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ABSTRACT

This study was planned (1) to identify factors, both social and academic, associated with the gender-role and self-concept perceptions of seventh and eighth grade adolescent girls relative to their participation in science; and (2) to determine the relationship of these emerging concepts of self to the attitudes and achievement of these girls toward science. For purposes of contrast, these two sets of relationships were also studied for the male peer group of the same educational level. Self concept and perception of gender role identities, as related to science, were investigated as pivotal variables which either constrained or supported early adolescents' interests and achievement in science. In addition to the variables associated with general aptitude and achievement of the youth, the influences of significant others (e.g., supportive parent, teacher, peer) were considered as potential antecedents to their development of the self concept in science. Self concept and gender-role identities were then viewed in relation to the adolescents' achievement and attitudes in science. Subjects for the year 1979-1980, were 175 grade 7 students. The next year, subjects were 190 grade 8 science class students. A battery of 14 instruments was employed for collecting data relevant to student achievement, attitudes, aptitudes, and classroom interaction. (PN)

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Relationship of Significant Others, Parental and Teacher Influences to the Development of Self Concept, Science Attitudes and Achievement among Adolescent Girls

Final Report

May 1982

NIE-G-79-0159

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INTRODUCTION

Traditionally, men and women have not been equally represented in career areas of science and technology. One major reason for this phenomenon may be that the area of science appears to be incongruent with the gender-role perceptions held by adolescent girls. Current literature suggests that girls self-select themselves out of courses in science and mathematics at the high school level (Haven, 1970; Sells, 1976).

The junior high school years appear to be the critical era for emergence of gender-role interests and differences in achievement between boys and girls in science and mathematics (Hilton, 1971; Hardin & Dede, 1973; Fox, 1976a). Lagging interests in science among adolescent females have been credited in the past to innate sex differences in their aptitudes for science and mathematics, as compared to their male counterparts (Fox, 1975; 1976a; Benbow & Stanley, 1980). Astin (1974) and Fox (1975), however, presented a rival hypothesis that gender differences in mathematical aptitude in adolescents result from social factors. The social factor theory also appears feasible for explaining the lag of adolescent girls' interests in science, since mathematics appears to be a major stumbling block for developing women's interests in science (Fox, 1975). According to Fox, the classroom itself serves as one area in which social roles in science and mathematics are learned through interactions with teachers and peers.

The role of social interactions and the influence of significant others in the development of women's interest and participation in mathematics has been fairly well established by investigators such as

Fennema and Sherman (1976, 1977); Armstrong (1980); Coleman (1961); and Hawley (1971). Sherman and Fennema (1977); and Sherman (1980) have also documented the influence of these factors upon the mathematics participation of adolescent girls. Such careful study, however, has not been given to the determination of social factors associated with early adolescent girls' participation and interest in science. The few studies that have been done, such as Stenner and Katzenmeyer's (1976) study relating self concept to achievement in science, and Casserly's study (1975) relating science interests, gender-role images, and career interests, have investigated isolated elements of the social influences/gender-role interests/achievement interaction, but no effort has been made to associate these relationships in a broad conceptual scheme, as has been investigated in this study.

The current study was planned with a broad two-fold purpose: (a) to identify factors, both social and academic, associated with the gender-role and self-concept perceptions of seventh and eighth grade adolescent girls relative to their participation in science; and (b) to determine the relationship of these emerging concepts of self to the attitudes and achievement of these girls toward science. For purposes of contrast, these two sets of relationships were also studied for the male peer group of the same educational level.

To accomplish the purpose of the study, self concept and perception of gender role identities, as related to science, were investigated as pivotal variables which either constrained or supported early adolescents' interests and achievement in science. In addition to the variables associated with general aptitude and achievement of the youth, the influences of significant others

(e.g., supportive parent, teacher, peer) were considered as potential antecedents to their development of the self concept in science. Self concept and gender-role identities were then viewed in relation to the adolescents' achievement and attitudes in science. These key concepts -- self-concept, gender-role identities, achievement, attitudes, and influences of significant others -- were seen to be critical to participation in science for adolescents.

The influences of significant others were broadened to include people from within the home and from the school. Parent influences considered in the study included situational and work variables, such as type of employment held by the parents and socioeconomic status of parents, as well as the adolescents' perceptions of their parents' attitudes toward their participation in science, selection of scientific career in both traditional and nontraditional areas, appropriate activities for participation of males and females, and educational expectations of their child. Teacher influences investigated included social-instructional interactions directly observed between teachers and students in science classrooms. In addition, the perceptions of the adolescents toward the influences of teachers and counselors serving as significant others in fostering interests in science were also assessed and related to the adolescents' self concept in science. Peer influences studied were those projected in sociograms of peer structure within the science classroom and those observed in student-student interactions in the science classrooms.

Plan of Research

Research Questions

Nine research questions were posed for this study. The first eight, however, were answered each year during the two-year period, describing the students' activities and progress in science at each level of the longitudinal study. The last question was answered only after the completion of the two-year investigation. The research questions offered for structuring the study are as follows:

1. What differences in classroom interactions are observed for male and female students in the science classroom relative to teacher-student interactions and peer-student interactions, respectively?

2. Are there differences in the domains of learning expected by teachers of male and female students as indicated by the types of questions asked of the students?

3. Are there differences in male and female students' concepts of self and gender roles relative to science interests?

4. What relationships exist between male and female students' classroom interactions and learning levels expected by teachers and the following variables: concepts of self and sex role in science, race, socioeconomic status, social rating by peers and students' perceptions of parental influences upon science interests?

5. What relationships, if any, exist between male and female students' achievement in science as measured by a standardized test and by grades earned in science; aptitude; and attitudes toward science?

6. What overall differences in learning outcomes in science are observed between male and female students relative to the following criteria: (a) achievement as measured by a standardized test; (b) grades earned in science; and (c) attitudes toward a science scale?

7. What relationships, if any, do male and female students' self concept and gender-role perceptions have toward their attitudes and achievement in science?

8. What set of all variables studied relative to attitudes of significant others, influences in the classroom, student achievement and attitudes, discriminates significantly between male and female students in science classes?

9. Will separate subgroups of males and females differ significantly between the seventh and eighth grades on variables associated with interactions in the classroom, self concept in science, gender-role attitudes, concepts of career appropriateness, attitudes toward science, achievement and aptitude in science, and perceived influence of significant others on science interests?

Each of these questions were addressed in this study. This report includes related research, a description of the research methodology, and the findings related to these research questions.

RELATED RESEARCH

Self Concept and Gender Role

Self Concept

One of the adolescent's most basic developmental tasks is the stabilization of self identity. Two factors, bodily changes and social processes, appear to be the interplaying forces as adolescents crystallize their concepts of self esteem (Protinsky and Farrier, 1980). Research on the stability of the self concept among early adolescents has yielded conflicting results.

Engel (1959) concluded that stability of self concept is achieved by adolescents earlier than eighth grade. Carlson (1965) also found self concept to be stable during adolescent years. Jorgensen and Howell (1969) noted no differences in ideal self/self congruence in either sex groups in the age range from 13 to 18 years.

Relative to career goals, Putnam, Hosie, and Hansen (1978) found no differences in overall self esteem among eleventh grade male and female students. Handley (1975), in a similar situation, observed no differences in overall self concept relative to the school environment between male and female educationally disadvantaged adolescents.

Engel (1959) found no sex differences among high school seniors but Carlson (1965) observed that senior girls developed a more social orientation in their self concepts while boys developed more personal orientation to self. Maccoby and Jacklin (1974) found the sexes to be highly similar in self-satisfaction and self-confidence during adolescence but that girls rated themselves higher in social competence. Stoner and Kaiser (1978) reported differences in self concept among high school seniors with males scoring higher on variables related to

personal self, social self and self-criticism. Their results supported the findings of Carlson (1965) relative to personal self, but conflicted with his data reporting girls to be more social in their self orientations than boys.

Bohan (1973), studying an early adolescent sample, recorded a drop in self esteem for females during that phase of development. Simmons, Rosenberg, and Rosenberg (1973) also demonstrated that self-image disturbance appeared much greater in early adolescent years than in pre adolescent years for girls. Garwood and Allen (1979) concluded that post-menarcheal girls, especially middle class females, were generally better adjusted on a self concept basis than were pre-menarcheal girls.

In older adolescents, Schludermann and Schludermann (1970) identified different personality traits associated with real self concepts for male and females. In this study the real-self variable, for males, was associated with the personality variables of self control, good impression and social insecurity. For females, the real self trait was correlated with personality variables of sense of well-being, self control, tolerance, good impression, and achievement via conformance. These two factors for each of the respective gender groups were labeled "social insecurity" for the males and "social impression" for the females.

As noted by Spence and Helmreich (1978) one of the cores of women's and men's self-concept is the degree to which they believe they measure up, or believe it important to measure up, to their abstract conception of what is to be a proper man or woman. These authors, as well as Bem (1981), have associated self concept in this

context with the development of a gender schema theory for describing differences in behavior.

Self Concept and Gender

As theorized by Bem, during development the child learns to choose from among many possible dimensions of human personality only that subset of traits defined by the social environment as applicable to his or her own sex. These dimensions are the psychological structures around which the child organizes his or her self concept. As the child learns to evaluate his or her adequacy as a person in terms of the gender schema, he or she matches his or her preferences, attitudes, behaviors, and personal attributes against the models for appropriate masculine and feminine behavior programmed by cultural expectations. Thomas and Robinson (1981) have studied this gender schema for definition of self concept in adolescents through the use of instruments developed from the Bem Sex-Role Inventory (Bem, 1974). Thomas reported that she found the same interaction between masculine and feminine traits as related to self concept and achievement in younger subjects as reported by Bem for older subjects.

In Bem's studies (1974), she assessed the extent to which a person endorses masculine and feminine personality characteristics as self-descriptive. Masculine traits as dimensioned in Bem's work are: acts as a leader, aggressive, ambitious, analytical, assertive, athletic, competitive, defends own beliefs, dominant, forceful, has leadership abilities, independent, individualistic, makes decisions easily, self-reliant, self-sufficient, strong personality, willing to take a stand and willing to take risks. Feminine traits as characterized in Bem's study are: eager to soothe hurt feelings,

flatterable, gentle, gullible, loves children, loyal, sensitive to needs of others, shy, soft spoken, sympathetic, tender, understanding, warm and yielding. Bem (1974) hypothesized that sex-typed males and females place limits on their behavior when they are required to perform sex-reversed activities, and such limits impede their problem solving. Consequently, Bem developed a scale which allows a person to label himself or herself as having both masculine and feminine traits (both cautious and adventurous, both assertive and yielding, i.e., with both masculine and feminine adjectives). Bem (1975) hypothesized that androgynous people can be situationally relevant in their problem solving.

Relative to gender-role identification, it also appears that the self concept of male and female adolescents is closely related to their concepts of masculinity and femininity traits. While male and female groups did not differ significantly on self esteem, Spence and Helmreich (1978) reported that both gender groups reported masculine self-traits which correlated more positively with self esteem than their self-reported feminine traits correlated with self esteem. By definition, Spence and Helmreich considered masculine traits as those considered socially desirable for both sexes but that males were believed to possess in greater abundance (e.g., independence). Feminine traits were considered to be those describing characteristics considered to be socially desirable by both sexes but that females are believed to possess to a greater degree than males (e.g., gentleness). Spence and Helmreich also discovered that traits measured on a masculinity-femininity scale which assessed personal traits of individuals whose social desirability is greater for one sex than the other (i.e., aggressiveness for males, non-aggressiveness for females)

correlated positively with self esteem of adolescents. Though the scale was structured to load for higher scores with traits identified as more appropriate for men, both male and female adolescent groups who assessed themselves to have these stereotyped more masculine traits also had higher self esteem. In brief, adolescents, regardless of their sex, who had traits identified as appropriately more masculine than feminine, also rated themselves higher on self esteem.

As noted earlier, the pivotal criterion variable in this study was considered to be self concept. Self perception was hypothesized as the intermediary variable relating social interactions of students to their productivity in the classroom setting. Wylie (1974), in summarizing the literature relating self concept to school productivity, left little doubt concerning the vital role which self concept plays in relation to the achievement and performance of students. Stenner and Katzenmeyer (1976) have demonstrated that self concept adds significantly to prediction equations for achievement in science, over and above the contributions of nonverbal intelligence. Staines (1956) demonstrated that teachers are significant others in changing the self concept of students through their comments and interactions with students. Other studies relating self concept to instructional patterns and classroom interactions in specific subject areas of science and mathematics are practically non-existent. The crucial question is whether the teacher actions in the classroom affect the students' perceptions of self relative to science activities, and whether this self perception is related to academic interests and achievement in science.

In investigating this question, it was deemed important to assess students' self perceptions relative to the specific subject area of science, rather than studying only their generalized self concept. Brookover, Shailer, and Patterson (1964) distinguished between global self concept and academic self concept which had specific subject matter referents. Soares and Soares (1977) developed a model for dimensionalization of self, identified as independence of self attitudes as related to various disciplines in the classroom, including science. Their instrument, the Affective Perception Inventory, provides a measure of how subjects see themselves in relation to science. They have been able to detect sex differences in self concept as measured by their instrument relative to science. Their self concept scale in science, according to Soares and Soares (1977), correlated only modestly with self as perceived in other subject areas, thus indicating a differential in attitudes toward self for this scale in comparison to other areas of academic activity. Self concept relative to the science area, however, correlated well with achievement in science. Thus, the perceptions of self dimensionalized by Soares and Soares (1977) appear to be those that might be sensitive to the sex-role interactions of the classroom, and at the same time, relate well to student achievements in science as projected in the proposed study.

Developing Gender Role Perceptions

The adolescent period may be the most significant era of development in determination of gender-role perceptions in individuals (Adams, 1973; McCandless, 1970). At least three of the seven developmental tasks associated with early adolescence by Thornburg (1980) are

concerned with sex-role development. They are: (a) learning new social/sex roles; (b) recognizing one's identification with stereotype; and (c) developing friendships with others. According to Thornburg, adolescents have strong gender role beliefs. Gender-role perceptions, according to Safilios-Rothschild (1979), in young children are associated with role imitations, parents' sex-differentiated behavior toward children, birth order and sibling status, parent absence, and same-sex and cross-sex influences.

The cognitive component of gender-role stereotyping concerns the extent to which individuals attribute to males and females, respectively, characteristisc stereotypically defined as masculine or feminine (Rosen and Aneshensel, 1976). These stereotypes are communicated to children early in their development and are reinforced through schooling and society throughout later childhood and adolescence (Pottker and Fishel, 1977).

Girls at an early age are socialized toward fulfillment through marriage and children. Males concurrently are encouraged to assume the provider-protect role. These societal norm expectations are introduced by parents and are reinforced by schooling experiences and through the influence of peer groups (Guttentag and Bray, 1976). The result of such social pressures is that male adolescents choose to participate in active-achievement oriented activities while females during adolescence spend more time cultivating their supportive, interpersonal skills.

Science and mathematics have long been thought of as the exclusive domain for males (Cohen and Cohen, 1980; Guttentag and Bray, 1976). Gander (1977), for example, found that 74% of the males and 84% of the

female high school students felt that more girls should be encouraged to take subjects in math, science, and industrial arts. Only 40% of the males and 58% of the females, however, believed that high schools should have more women teachers in these instructional areas. Over one half of the sample of male students in Gander's study also felt that mathematics and science are usually taught by men because men are mentally and physically better adapted for study in these areas than women.

In general, studies identifying science and mathematics as male domains have focused upon the strong conflict in girls between academic achievement and popularity. Adolescent girls choose not to elect these subjects because it might hinder their relationship with boys (Coleman, 1961; Hawley, 1971; Sherman and Fennema, 1977). A rival hypothesis, however, is that there is a relatively low incidence in females with active science-based career interests to serve as role models for girls as they enter adolescence.

Role imitation or modeling is a theory used to explain differences in gender-role perceptions of children. The "significant other" construct discussed later in this paper is related to the role model theory. In science and mathematics, research studies considering the influence of role models have focused on the masculine identity hypothesis that both male and female adolescents who identify with their father or a father figure are more interested in science and mathematics than their counterparts selecting female role models (Fennema and Sherman, 1977). Epstein and Leverant (1963) supported the father dominance hypothesis by noting that the father is the reality enforcer of young children and thus becomes the more salient figure influencing their social learnings. This position, however,

was disputed by Maccoby and Jacklin (1974) who argued that females are more salient models for young children, if it is assumed that identification for the child is first made with the mother. In this context, then, the work experience and the interests of mothers in science and mathematics would be the critical factors in keying youth to become involved in these areas.

As reviewed by Safilios-Rothschild (1979), the literature related to sex role clearly demonstrates that as children boys and girls are treated differently by parents. Boys get more tactile-visual stimulation and are aroused to higher activity levels than are girls. Boys are given more independence training, more punishment and more intellectual encouragement than girls during pre-school days. Mothers expect girls to be more dependent and they give girls more physical attention. Parents also award boys' aggression as appropriate "masculine" behavior, but girls' aggression is never awarded. The pressure on girls, as reviewed by Safilios-Rothschild, is for "feminine" qualities, such as neatness, obedience, and conformity, but pressure on boys is for independence and achievement.

Birth order and sibling status are two variables associated with development of sex-role identification which have been explored in great detail in the literature. However, as noted by Bragg and Allen (1970), research findings relating these variables to sex-role identity have been contradictory. Brim (1958) successfully utilized a role theory perspective to account for variations in sex-role learning based on differential sibling patterns. His basic assumption was that interaction between two persons leads to assimilation of roles. In this perspective, opposite-sex siblings are more likely than same-sex siblings to incorporate traits of the other sex. Younger siblings

are influenced more by this incorporation process since older siblings have had longer to establish their own role and are not so role dependent. If Brim's assumption is true, then girls with older brothers should display more interest in science and mathematics, if brothers encourage these interests. Older brothers have been identified as role models for girls as they developed their interests in mathematics (Armstrong, 1980) and interest in nontraditional careers (Handley and Walker, 1978). The influence of siblings upon students' interest in science has not been investigated.

Same-sex and cross-sex influences of peers on the development of gender-role identifications of youth have also been thoroughly explored in the literature. As stated by Safilios-Rothschild (1979), the general consensus is that, as males are developing attitudes toward gender roles, they are primarily influenced by other males, regardless of the age level studied. Although same-sex friends and peers are also more significant than opposite-sex peers for adolescent girls, the evidence is that the importance of opposite-sex friends is greater for girls than boys. Although adolescent girls confide and receive support from female friends, the males are the normative reference group that sets standards for their appropriate behavior. Male acceptance is paramount in importance to girls at this age since one of their important interpersonal goals is to achieve popularity (Woelfel, 1972).

That schools reinforce the stereotyped views which both males and females have developed in the home and social milieu toward appropriate gender-role behavior is a condition recognized by many writers including Pottker and Fishel (1977) and Guttentag and Bray (1976).

In formal school programs, stereotypes have been found to exist in the types of institutional materials used and teachers' attitudes and behavior toward boys and girls (Guttentag and Bray, 1976).

Achievement and Aptitude

Differences in Achievement

In a survey of science achievement by the National Assessment of Educational Progress (NAEP) program, it was reaffirmed that average science achievement is higher for early adolescent male students than female students (National Center for Education Statistics, 1978). Furthermore, when the performance in science of thirteen-year-old females in 1977 was contrasted with that of their age counterparts' performance in 1970 and in 1973, it appears that the earlier downward trend in science achievement is lessening. Achievement in biology for early adolescents appears to have stabilized while a slight decline in physical sciences was still indicated between students' scores in 1973 and 1977.

In 1978, two surveys were completed comparing the achievement of girls in mathematics at age 13 and grade 12. Since achievement in science is closely related to achievement in mathematics, data from these two surveys appear to have significance for this study. The first study was the NAEP Mathematics Assessment, 1977-78 (National Assessment of Educational Progress, 1979). A national sample of thirteen-year-olds indicated that the two sex groups were similar in algebra achievement. The males, however, scored significantly higher than the females on mathematical applications. In contrast, the females scored significantly higher on mathematical computations.

In the second survey, the Mathematical Achievement for Women in Mathematics Survey (Fall 1978), thirteen-year-old females scored higher than males in spatial visualization and computation. No differences were observed in the performance of the two groups relative to algebra achievement and problem solving (Armstrong, 1980). Armstrong's data, however, indicated that males achieved significantly better in problem solving than their counterpart females at the twelfth grade level. Though results of these two studies are somewhat contradictory, it appears that thirteen-year-old females start their high school mathematics studies with at least the same ability as their male classmates. By the twelfth grade, however, males have overtaken females.

Maccoby and Jacklin (1974) reviewed sex differences which have implications for explaining the differential achievement of males and females in early adolescence. They summarized the differences as follows:

1. Females test higher in general intelligence during preschool years, and males test higher during high school. At the early adolescent level, little differences are observed in verbal ability, except that females do better in grammar, spelling, and word fluency.

2. No differences in number ability are evident in the two sex groups during their early years, but males at the high school level do better at arithmetical reasoning.

3. Males consistently perform better than females on measures of spatial ability from early grade school on through high school.

4. Sex differences in analytical abilities are not really clear. Males, however, seem to do better at this cluster of traits from time of entry to school on through adolescence.

5. Males do better with the manipulation of objects and trying a range of approaches in problem-solving than females.

6. Females get better grades at all levels of education, even in subjects on which males excel on standardized achievement tests.

Differences in Aptitude

Differences in achievement of males and females in science and mathematics at the high school level have been hypothesized to be related to differences in cognitive factors in two trait areas: (a) differences in spatial ability (Bishop, 1978; Tobias, 1978; Sherman, 1967; Baker and Talley, 1974) and (b) differences in problem-solving abilities (Maccoby and Jacklin, 1974; Graybill, 1975; Block, 1965).

Maccoby and Jacklin (1974) concluded that, beginning with adolescence, consistent sex differences exist in spatial abilities. In their review of the literature, they found that males performed better than females on tests of nonanalytical spatial ability in eight of ten studies reported. On this same review, studies of analytic spatial ability showed males scoring higher in 22 of 43 studies while females scored higher in one study. Wittig and Petersen (1978), in their update of literature review in this area, reported similar differences between sexes. Six studies were found to indicate a higher male performance in nonanalytic spatial ability while one (Fennema and Sherman, 1977) found significant differences in the samples from only two of four schools studied. In an even more recent study of eighth graders, Sherman (1980) reported no sex differences in males and females in mathematical problem solving or in spatial visualization. Both factors, however, correlated significantly with achievement in mathematics. By the eleventh grade, significant differences were

indicated (favoring the males) in mathematical achievement in Sherman's study.

Can ethnic background of subjects be an intervening variable in explaining differences in spatial abilities? Schratz (1978) discovered no significant difference in spatial abilities for white male and female preadolescent and adolescent groups, respectively. She found, however, a sex by ethnic origin interaction associated with spatial abilities which indicated that differences existed in the spatial abilities of other ethnic groups. The Hispanic female group, for example, scored significantly higher on spatial relations than did the male group of that same ethnic background. A similar trend toward female superiority was seen in the scores of the black adolescent groups, even though this difference failed to reach statistical significance. This same ethnic group by sex interaction as related to spatial performance was not observed by Jahoda (1980) when he compared spatial performances of early adolescents in Ghana and Scotland. Within each of the two countries, male subjects outperformed their female counterparts on three dimensional mental rotation tasks.

During early adolescence many youth are in the stage of cognitive development defined by Piaget and Inhelder (1958) as transitional between concrete thinking and formal thinking. Maccoby and Jacklin (1974), after reviewing 50 related studies, concluded that no overriding sex differences were discovered in both pre adolescents' and adolescents' abilities to complete Piagetian tasks. In another study, however, Graybill (1975) reported that males were more successful than girls in solving Piagetian-related science problems. She reported that

boys and girls began to show differences in logical-thinking abilities at about 11 years of age, when the girls began to lag behind the boys. She also noted that girls had more difficulty than boys in constructing and manipulating apparatus. This difference was particularly observable at the age of 13. Boys appeared to be more careful in determining accurate measurements of length while girls were more satisfied in giving a rough estimate of measurement. She concluded that not one of the 12 girls included in her study was identified as having attained the formal thinking level, while the boys began to score at this level at about age 13.

Douglas and Wong (1977) also discovered sex differences in performance of formal-operational-concept tasks favoring males in their cross-cultural study of Chinese and American youth in the 13-15 year age range. Leskow and Smock (1975) found gender differences in problem-solving strategies where adolescent males outperformed females on completion of four permutation tasks. Keating and Schaefer (1975) found that younger bright boys in the 10-13 age range scored higher on formal-operations tasks than did girls, even though the girls were 10 months older.

In a broader socialization contest, Lynn (1972) explained male superiority in problem-solving skills as being associated with their gender-role identification. Males acquire a cognitive style in solving the masculine-role identification problem that is applicable in solving other problems. In contrast, the feminine cognitive style from the process of learning the mother-identification lesson, is not well geared to problem solving. Consequently, according to Lynn, females are surpassed by males in problem-solving skills. Milton (1957) supported Lynn's position when he discovered there is a

positive relationship between problem-solving skills and the degree of masculine gender-role typing, both across sexes and within each gender group. When variance associated with gender typing was controlled by Milton, he noted that the difference between the problem-solving performances of men and women diminished. Hoffman and Maier (1966) noted that the influence of gender-role identification on problem-solving strategies evident in adults probably became most activated during adolescence.

Differences in Motivation for Achievement

Differences in achievement and attitudes toward science among males and females have been explained by Wittig and Petersen (1979) to be related to an achievement motivation construct associated with gender-role self concept variables. This achievement is more typical of females manifesting "masculine" interests by pursuing nontraditional fields. Sundheim (1963) found that among female undergraduates, science majors had higher achievement motivation than language majors, who were more achievement motivated than elementary education majors. Similarly competitive, intellectually-oriented undergraduate females (French and Lesser, 1964) displayed high achievement patterns similar to those of males. Spence and Helmreich (1978) identified more traits of masculinity and androgyny to be associated with women earning doctorates in science than with female college students, in general.

Among high school girls, academically successful students defined achievement as more gender appropriate than underachievers did (Lesser, Krawitz, & Packard, 1963). Topol and Reznikoff (1979) observed that the educational goals of achievers among high school senior girls with strong academic aptitudes were significantly more ambitious than those

of their underachieving counterparts. The career goals of the achievers were more contemporary than those of the underachievers (i.e., More of the achievers choose careers in the areas of law, dentistry, medicine, and architecture while the underachievers chose traditional women's careers.). Topol and Reznikoff noted no differences in attitudes toward women and fear of success as motivators for the achieving and underachieving high school girls.

Stein and Bailey (1976), in reviewing the literature associated with achievement drops for female adolescents, concluded that reduced achievement efforts occur for many young women at this age because there is pressure to adhere to feminine role definitions an because females internalize the low expectations of the culture for their continued achievement. Attainment in the occupational world, according to Stein and Bailey, not only produced some negative sanctions but also require the self-esteem and assertiveness that are contrary to traditional feminine personality attributes. Stein and Bailey, however, pointed out that less achievement "drop-out" is observed in females studying in areas congruent with their feminine sex role.

Maccoby and Jacklin (1974) postulated six hypothetical factors influencing differences in achievement motivation for males and females. They were: (a) need for achievement, (b) persistence, (c) risk-taking, (d) task-orientation vs. person orientation, (e) intrinsic vs. extrinsic motivations, and (f) self concept. After a careful review of the literature on achievement motivation, they concluded that no real support existed at the time of this study for any of these hypotheses. They found a real scarcity of

research studies testing these hypotheses with subjects during the adolescent years. Existing studies, according to Maccoby and Jacklin, were incomplete and yielded contradictory results.

Attitudes toward Science

Difference in Attitudes toward Science

In a nationwide study among adolescent groups, it was found that males were more likely than females to have favorable attitudes toward science classes and science-related careers, to have more science-related experiences and to use the scientific method of inquiry (National Assessment of Educational Progress, 1979). More males than females claimed to participate in science related activities outside science classes. More males than females had participated in activities associated with electricity, while more females had participated in the more passive activities of science, such as leaf collecting, taking care of animals and growing plants. The adolescent girls not only expressed less interest in science than boys, but the girls' interests in science became even less active as they matured from age 13 to age 17.

Male and female teenagers' support for research and awareness of the method and philosophy of science were about the same. At the adult level on the national survey, however, more males demonstrated support in these areas than females.

Gender differences in attitudes toward science demonstrated by National Assessment study reflected similar patterns discovered by earlier investigators. Welch (1969) and Aiken and Aiken (1969) both indicated that sex is a significant factor in predicting students' attitudes toward science. In both studies, females expressed fewer

positive attitudes toward science than did males. Moore (1973) found that gender difference favoring males was a significant predictor of high school students' attitudes toward involvement with science and scientists. Keeves (1973) reported that males have greater interests and more positive attitudes toward science and mathematics in other countries, as well as in the United States. He cited the roles of differing sociocultural expectations and reinforcement schedules, complemented by same-sex role modeling as important determinants of gender differences in attitudes and achievement in science and mathematics.

In summary of the differences in achievement, aptitude and attitudes in science, the literature indicates that gender differences in achievement and attitudes toward science emerge during the early adolescent years and become even more evident during the later high school years. There is support for relating attitudinal and achievement differences with gender-related differential abiliites in spatial relations and problem-solving. Motivation for girls' achievement in the male-dominated area of science may also be related to their personal gender-role concepts. As reported earlier in this paper, motivation in science and mathematics is supported by positive influences of significant others toward adolescents. There is little or no evidence, however, currently available to relate achievement motivation in science to hypothetical differences in need of (a) achievement, (b) persistence, (c) risk-taking, (d) task orientation vs. person orientation, (e) intrinsic motivation vs. extrinsic motivation, and (f) self concept between adolescent males and females.

Role of Significant Others

Significant Others

Early investigators such as Brandwein (1952), Roe (1951), Handley and Bledsoe (1968) noted the importance of social interactions and psychological support of "significant others" in fostering talented youths' interests and career development in science. Fox, Pasternak and Paiser (1976) also reported that the support of others who are admired and respected is an important prerequisite for sustaining the development of girls' attitudes and achievement in mathematics and related areas through their transition in establishing gender-role identities during early adolescence.

From a broader perspective, the influence of significant others has been identified by Ginzberg, Ginzberg, Alexrod and Herman (1951) to be of paramount importance as adolescents grow from more subjective to more realistic modes of decision-making in their career development processes. Significant others projected as influential in career development by theorists such as Ginzberg (1952) and Super (1957) are parents, teachers, and other influential adult role models. More recent literature (Trigg and Perlman,1974) also suggest that peers are also the significant others when females consider whether to study in courses such as science and mathematics which are stereotypically considered the domain of the opposite sex. The peer group, rather than parents and teachers, may provide the dominant attitudinal reference group for adolescents; hence, they may well be the "significant others" in which junior high school age students see their expected sex role reflected most intensely. Significant others, according to Sullivan (1947),may be a social norm group, as well as specific individuals.

In their studies of gender-role bias as associated with adolescents' decisions to study for nontraditional careers in vocational education, Handley and Walker (1978) found close interactions between students' concept of self, their attitudes toward appropriate gender roles and their decisions to study for careers considered nontraditional for their gender group. Armstrong (1980), in her overview of achievement and participation of women in mathematics, reported a similar inter-relationship between girls' interests in mathematics and gender-role self images. She found that parental influences, as well as the influence of others, such as peers, counselors, teachers and siblings, interacted with concepts of self and appropriate gender roles to predict the achievement of early adolescents in mathematics. Similar studies have not previously been reported to demonstrate the interaction of these variables in predicting girls' achievement and attitudes toward science.

The role of significant others in nurturing students' involvement with science is closely associated with a social theory of self. Students express attitudes and make decisions on the basis of the self which they see reflected in the looking glass of associates. This construct has been historically developed through the work of such psychologists as Cooley (1902), Mead (1934), and Sullivan (1947), and more recently, Rogers (1951), Goffman (1959), and Webster and Sobieszek (1974). Webster and Sobieszek view self concept as being induced by environmental influences; and, in turn, self concept is a major determinant of individuals' action within and upon their environment. As noted by Soares and Soares (1977), concepts of self may be restricted to a specific area of endeavor, such as in this study.

Significant others, within the context of this study, are those whose opinions about science and its appropriateness for study by girls are important to the individual. These people are the ones whose esteem is valued and whose psychological censure is avoided if possible. Additionally, attitudes of peers as perceived by the subjects, as well as those for parents, educators, and other possible role models, were considered as factors potentially influencing the attitudes of junior high school students toward science and toward participation in science activities.

Under the social self construct, significant others for young children are generally parents or parent substitutes. When the children go to school, the teacher group becomes a source for the selection of significant others. As the youngsters mature the significant other influence shifts toward the peer group whose impact crests during senior high school. Curtis (1974) found that early adolescents (seventh and eighth graders) did not shift their reference sources from parents to peers as would be expected from the writings of other theorists describing adolescent development. He found that while both males and females decreased in their valuations of both parents, they also decreased in the valuations of their friends. His conclusion was that these adolescents were becoming more independent-minded and less directly influenced in their attitudes and activities by significant others. He found, however, that among girls from lower class families the decrease in valuation of mothers was less evident. In contrast, lower class males, as contrasted to other socioeconomic-gender subgroups, increased in the valuation of friends. Research studies by several investigators have found that the science interests, gender-role images and career interests

during the transition era of early adolescence are enhanced by both authority figures and peers (Casserly, 1975; Fox, 1976a).

Parental Influences

The influence of parents upon the socialization experience of the genders is well documented by Maccoby and Jacklin (1974). Parental influences upon their children's studies in science and mathematics have also been documented, although the few studies that have been done have been done more often in math than in science.

Roe (1951) identified the influence of fathers and other dominant male figures as significant others serving as early determinants of science-related vocational choices. Handley (1966) discovered that research-oriented female students in graduate studies in science claimed male figures (including both parents and teachers) as their mentors. These research findings, however, may reflect the relative absence of mothers and other women adults with science interests as potential role models.

Several investigators (Haven, 1970; Luchins, 1976; Poffenberger and Norton, 1959) reported data that support and encouragement from parents are crucial factors associated with their offsprings' decision to elect or not to elect mathematics courses in high school. Poffenberger and Norton (1959) found that male students were more likely to have positive attitudes toward mathematics if the father both liked mathematics and was good at it. Daughters, however, did not display similar attitudes toward mathematics under this same condition.

Parental expectations as reported by Hill (1967) and Casserly (1975) influence students' achievement in mathematics. In general, parents have lower expectations of daughters in mathematics than of sons. The expectations of the father, not his attitudes or occupation, influence achievement of girls in mathematics (Fox, 1976b). Armstrong (1980) verified the importance of fathers' educational expectations in determining females elective participation in math while in high school.

Related to gender-role development and its connection with career development, Lueptow (1980) concluded that the father is the most important determiner of both male and female sex-role patterns. According to his studies, there is no evidence of change in patterns of socialization during the 1964-75 decade, nor has the pattern of social role antecedents changed appreciably. According to Lueptow, father influences appeared to be more related to fathers' expectations and reciprocity rather than direct imitations of parental behavior.

Contrary to Lueptow's findings, Banducci (1967) reported the work role of mothers was a crucial factor associated with daughters' gender/work role perceptions. Adolescent daughters of working women were more likely to view favorably working outside the home when they became mothers. Douvan and Adelson (1966) reported that at the high school level the population of daughters with mothers who had chosen careers in nontraditional work areas also had more career interests in nontraditional work areas also had more career interests in nontraditional fields than did the daughters of mothers who remained in the home. Burlin (1976) discovered that mothers' work, in itself, was not enough to encourage girls to aspire toward innovative careers. What appeared

to be important in Burlin's studies was whether the mother was currently employed in a nontraditional innovative job at the same time the adolescent females' interest in nontraditional careers was surveyed.

Burlin also found that fathers' educational level was pointedly related toward aspiration of the young women toward innovative career choices. Kandel's study of the career aspirations of adolescent black males and females, however, did not reflect Burlin's finding. Kandel (1970) found that career aspirations of black adolescents were more associated with maternal influences than paternal. Black mothers and adolescents had higher educational aspirations than whites. Yet, these same aspirations, according to Kandel, were not reflected in the levels of education actually obtained by parents.

In summarizing the literature related to parental influence, it is evident that parents, and particularly fathers, have significant influence upon the social/work-role perceptions of both male and female adolescents. It is also clear that parental interests, aspirations and expectations, again particularly those of the father, are also determinants of their offsprings' interest in mathematics and science. Since fathers' educational expectations of daughters is one of the best predictors of girls' interests in mathematics and since fathers' perceptions of appropriate sex roles are paramount influences on their daughters' career interests, it is evident that attitudes of fathers may be early determinants of females' decisions to prepare for careers in science and mathematics. Certainly the attitudes of male parents should be closely associated with girls' participation in science during the early adolescent years while, as noted by Curtis (1974), parental influence is still dominant.

Positive effects of mothers' attitudes on science participation are not so clearly evident. Perhaps the lack of evidence to support this relationship is due to the condition that mothers, to a great extent, experience less involvement with science themselves as they grew up. Or it may be that girls accept the historically stereotyped view that science is a field for males; therefore, the attitudes of males should be valued when making decisions to study science.

Teacher Influence

Relative to the school setting, Fox (1976a) identified teachers and peers as being important significant others in the career development of students in science-oriented areas. Counselors were viewed as having less active support roles in career development among students in science and mathematics.

Teacher-pupil interactions in instructional settings have been shown to be related to affective outcomes (Rowe, 1974; Santiesteban, 1976) and cognitive learning (Siegel & Rosenshine, 1973) in science. In a Mississippi sample, teacher-based variables, such as number of classes taught, pupil-teacher ratio, highest degree held, and years of teaching experience were also shown by Ziarko (1976) to correlate significantly with student achievement in science.

Teacher expectation as postulated by Rosenthal and Jacobson (1968) has been demonstrated to have a large effect upon student achievement (Dusek, 1975; Lockheed, 1975). Anderson (1963) also demonstrated the positive relationship between non-sexist and enthusiastic teacher behavior and the intellectual development of girls in science. Unfortunately, studies of teacher-student interactions also show that teachers interact more with males than female students in science

classes (Bean, 1976; Parsons, 1979). Good, Sikes, and Brophy (1973) compared the behavior of male and female teachers with adolescent male and female students. Boys interacted more frequently and aggressively with teachers than did girls. Teachers were more apt to ask boys process questions and to ask girls product and choice questions. Though male and female teachers had different instructional styles, they did treat boys and girls different.

To study teacher-student interactions, Shymansky (1976) developed an observation scheme classifying students' interactions with peers and teachers in terms of ten categories designating different degrees of involvement for student subjects. Shymansky and Penick (1979) also reported a classification of teachers' behaviors in classroom interactions utilizing fifteen different categories. These classifications categorize teacher interactions ranging from passive observation to asking extended thought questions. According to these authors, these instruments have discriminated modestly between behaviors of male and female teachers and, to a lesser degree, between male and female students in the classroom. Such observed behaviors, however, have not yest been successfully linked to students' achievement in science. Possibly the reason for this lack is that the teacher and student behaviors have been described for groups, as a whole, rather than in terms of individual students, i.e., the data were coded as total number of teacher and student behaviors displayed in the group and not as the number of times that the teacher talked to Mary or to John and, subsequently, what social interactions were observed for John and Mary.

Baird (1976) summarized the literature related to sex differences in group communication in terms of a gender-role theory of behavior. These differences appear to reflect traits of males which are characteristics of science-oriented students (Handley and Bledsoe, 1968). Baird described males as being encouraged to be independent, aggressive, problem-oriented, and willing to take risks in social interactions. Females, in contrast, are more willing to self-disclose, more expressive of emotions and perceptive of their emotional states, more sensitive to non-verbal cues, less interested in problem-solving, relatively unwilling to assume risks, and more yielding to social pressures. Baird noted that in the current zeitgeist of liberality in reinterpreting women's roles, these behavior patterns are rapidly changing. Whether or not Baird's summarization of social traits for the two sexes are stereotypes, he identified several traits in the sex groups that can be observed in classroom behaviors. The current study investigates the cognitive base of such teacher-student interaction and relates these findings to student achievement and attributes toward science.

As reviewed by Fennema and Sherman (1976), many studies show that students' attitudes toward mathematics are highly related to their experience with teachers. Students' perceptions of what the teacher thinks of them and their ability in mathematics relate to students' interest and participation in math-related subjects. Parsons (1979) found a direct relationship between teacher expectancies and students' expectancies for success in mathematics.

Ricks and Pyke (1973) observed teachers of both sexes to report that boys and girls behave differently. Male students were more

preferred than female students by teachers as a whole and especially by female teachers. Brandt and Hayden (1975), however, observed that teachers of both sexes tended to rate the work of boys and girls to be of equal quality.

Students who have had same-sex teacher models have a greater science commitment than students who have had opposite-gender teacher models, according to Stake and Granger (1978). They found this same condition for both male and female students. The influence of same-sex teachers, as interpreted by these investigators, was related to the teachers' attractiveness as viewed by students. Only those students who viewed their same-gender teacher as moderately or highly attractive reported higher science commitment. The influence of the same-gender teacher model was also related to the amount of contact between teacher and student. Students working on individual projects requiring much teacher-student interaction were more influenced in their science career interests by teachers of the same gender.

Almquist and Angrist (1971) discovered that teachers serve more as occupational choice role models for career salient women and less as career models for non-career salient women. Handley and Hickson (1978) also found that teachers were significant others in influencing the career development patterns of women who study mathematics. Next to parents, teachers were the most important "people" influences in the career development of women who chose to teach mathematics, as well as those who chose to enter nontraditional work areas closely related to mathematics. Handley (1966) observed that effective science teachers also identified other teachers as their most important career influence.

Counselor Influence

According to Casserly (1975, 1979), counselors appear to have a negative or neutral effect on girls who want to pursue mathematics or professional careers. Thomas and Stewart (1971) reported that counselors, in some cases, advised further counseling when girls wanted to pursue nontraditional careers and often discouraged girls from pursuing mathematics. There is evidence, however, that attitudes of counselors toward supporting the career development interests in nontraditional areas is changing. Handley and Walker (1978) found that adolescent girls electing nontraditional programs of study while in high school valued the opinions of their counselors regarding appropriate career choices. Black adolescents, particularly, felt that counselor opinion was important input into their decision to enter study programs leading to nontraditional jobs. Armstrong (1980) also found that involvement of both males and females with mathematics in both the seventh and twelfth grades, respectively, was related to counselor encouragement.

Peer Group Influences

Attitudes of the peer group have been characterized by Almquist and Angrist (1971) as reinforcing existing stereotypes and attitudes of students relative to career development concepts. In studies of the career development patterns for students in nontraditional vocational areas, Handley and Walker (1978) concluded that the peer group, as well as parents and teachers, serve as the significant others whose attitudes are perceived as less supportive of female adolescents studying in career areas considered nontraditional for their gender.

Significant others, according to Sullivan (1947), may be a social norm group, as well as specific individuals. Therefore, peer group interaction in the social climate of the classroom may either stimulate or retard the positive attitudes of students toward an area of study. Cohen and Cohen (1980) observed that peer pressure magnifies the need to conform to sex appropriate norms. A boy or girl who deviates from these norms is considered suspect. Since mathematics and science are subjects in the prescribed male domain, girls who show interest in these areas may be delegated to the outside perimeter of the peer social group.

Peer pressures against girls in science are less well-documented than for those in mathematics, but the same patterns of influence appear to emerge. Solano (1976) found that adolescents have a more negative stereotype of mathematically talented girls than boys. According to Fox (1976b), peer pressure against achievement in mathematics and related studies may be directed more strongly from male than female peers. Entwisle and Greenberger (1970), for example, discovered that for ninth graders, the higher the intelligence and social class for boys, the less the males expected women to achieve as scientists, doctors or other professionals. Fennema and Sherman (1977) discovered that males, more than females, considered mathematics as a male domain. Shepard and Hess (1975) reported that females of all age levels except kindergarten were more liberal than males toward appropriateness of all areas of study for both males and females.

Armstrong (1980) reported that peer influence was positively correlated with mathematical interests of both thirteen-year-old males and females.

Though parents were seen as the more important reference source by adolescents as a whole, Constanzo and Shaw (1966) found that among females from lower status groups, the influence of friends and fathers were of equal importance as arbitrators in social role conflicts. Older female adolescents, according to Husbands (1970) are more concerned about male friends than female perceptions of their femininity.

Ide, Parkerson, Haertel and Walberg (1981) concluded that peer influence is a strong, consistent determinant of a wide range of educational outcomes for both elementary and high school students. In their studies, peer influence was found to be stronger in urban settings and was also higher in studies where the peer influences investigated were career aspirations and achievement levels of best friends, as perceived by the subjects. Otto (1970) described influences of parents, friends, and girl friends as having equal values on the educational aspiration of male youth, but only parents were found to influence the career aspirations of the males.

Hout and Morgan (1975) stated that peer expectations, as an influence in the development of future plans for girls, seem to involve a race by gender interaction variable; that is, white males and black females appear to be particularly sensitive to peer influence in planning their career expectations, while white females and black males appear to be less sensitive to peer opinion. Relative to the selection of nontraditional career areas, Handley and Walker (1978) also described a similar pattern of peer influences for white males and black females. Wide differences, however, were observed in peer influence patterns for white females who elected to study in nontraditional areas of vocational education as compared to white females who studied in programs considered traditional for their gender.

In summary, the literature shows that peer group influences are important in determining the educational expectations of youth. Peer influence on the development of future occupational expectations are not as clear. Though a relationship between peer influence and girls' participation in mathematics has been observed, this association has not previously been studied relative to science.

Other Sources of Influence

Siblings may also influence the interests of adolescents in science and mathematics. Grotevant (1978) concluded that girls with sisters tended to develop less feminine interests. Since science has been stereotyped as a male area of activity, girls with older brothers may develop more interests in science than their counterparts with no such sibling relationships. In mathematics, brothers were reported as serving as role models (Armstrong, 1980) for adolescents while sisters were not. Brothers also served as important male role models for black females studying in nontraditional areas of vocational education (Handley and Walker, 1978).

Scientists also serve as role models and either directly or indirectly influence the students' interests in science. Handley (1966) found that research scientists often helped talented youth with independent studies in science and were recognized as important sources of inspiration in their career development. Roe (1951) and Brandwein (1952) also recognized the influences of research scientists in the career development of youth.

Attitudes Toward Career Choices

Traditional gender roles in career choice decisions are in the process of change (Mason, Czajka & Arber, 1976). Male and female adolescents, however, still show gender differences in attitudes toward women's work roles: boys studies by Mason and his associates had more traditional attitudes toward appropriate careers than girls did. Among rural youth, Handley and Walker (1978) found that while stereotyped views of work roles for women existed in both male and female groups, the males were less receptive to women pursuing non-traditional jobs. White and Ovellette (1980) discovered that 100% of an eighth grade male group also preferred traditional occupations for females. At that same grade level, females were nearly evenly divided (48% for and 52% against) in attitudes toward nontraditional jobs for women. Over 80% of the females preferred traditional work roles for men.

Cegelka, Omiv, and Larimore (1974) found differences in vocational interests of adolescent males and females. Males rated themsleves higher than females rated themselves on vocational interests in machine work, inspecting and testing, crafts and precise operations, numerical appraisal and applied technology -- areas of vocational activity closely allied with science career interests.

Early adolescence (ages 12-14) is a time in which youth are in transition between two periods of occupational choice as defined by Ginzberg (1952), the period of fantasy choice and the period of tentative career choice. Hence, occupational preferences expressed by youth at this time must be considered tentative at best. Katz (1979), however, observed that adolescence is one of the best times to

examine attitudes toward gender roles and the relationship of these variables to youths' concept of appropriate work roles for men and women. It should be noted, also, that interests in science for both scientists and science teachers developed early (Lee, 1963) and were reinforced during junior high and senior high school years.

Hollander and Parker (1972) and Simmons (1967) have demonstrated that adolescents' perceptions of career stereotypes are closely related to their own self perceptions and to their choice of careers. Simmons reported that adolescents planning to enter engineering were those whose self-perceived personal traits were in congruence with their stereotyped perceptions of engineers. It follows that since science is stereotyped as a male domain, young female students have a difficult time reconciling potential career goals in this area with their own gender-role concept. Though gender-role attitudes have not been studied directly in relationship to science career interests, Harren, Kass, Tinsley, and Moreland (1974) showed that such attitudes influence career choices in gender-dominant areas of work.

Two investigators, Frieze (1978) and Rossi (1965) studied career stereotypes in science held by older students. Frieze (1978) reported that college students expected women to have a more difficult time being successful in science than men. Both men and women subjects cited ability and effort, as well as having a strong interest in science and research, as prerequisites for physicists. Failure in scientific careers was perceived by both men and women as resulting from lack of persistence, inadequate training and lack of ability.

In her extensive study of barriers to women's choosing engineering, medicine, or science as careers, Rossi (1965) discovered that 54% of a sample of women college graduates felt that a job as a research

scientist was too demanding for a woman to combine with family responsibilities and 80% of the women offered this same reason to explain the relatively low number of women becoming doctors. Over 50% of the sample of women in Rossi's study offered three reasons why more women do not become engineers: (a) women are afraid they will be considered unfeminine if they enter this field (61%); (b) most parents discourage their daughters from training for such a field (57%); and (c) men in this field resent women colleagues (56%). Nearly one-fourth of the women college graduates felt that engineering requires skills and characteristics which women do not have. Only four percent of the women felt that women do not possess the skills and characteristics to become doctors, and only six percent felt that women had the ability to become research scientists. Data from Rossi's study demonstrate the awareness in women of gender-role stereotypes introduced by parents and later reinforced by peers which restrict women's career interests in science. Whether or not adolescent girls are conscious of these social role influences on their potential career interests remains to be demonstrated.

METHODOLOGY

Research Procedures

Overview of Research Design

The basic design of this research was ex post facto, and hence, correlational in its nature. Data were interpreted in terms of identifying existing relationships, rather than implying a causal inference between the antecedent variables and the attitudes and achievement of the students in science.

The data reported results from a two-year study of variables associated with achievement and attitudes toward science of the same students enrolled in the seventh and eighth grades, respectively. Data were collected toward science, academic aptitude, self concept as related to science and school, gender-role perceptions, career plans and perceived influence of parents and significant others. In addition, three observations were made each year of each science classroom to record instructional interactions among students and teachers, to determine wait time between teacher-student interactions and to assess the level of cognitive skills elicited from individual students. Background data related to parental employment, family socioeconomic status and prior achievement were collected from the cumulative academic folders of students.

The same data collection procedures were used for each year of the two-year study. The instruments were administered and observations were made from February through May in 1980 and 1981, respectively.

The Setting of the Study

Subjects of the study consisted of students enrolled in general science in a rural middle school in south central Mississippi. This school contains most of the students of middle school age taught in an entire separate school district serving the entire county. Students from the cooperating school are nearly equally balanced according to race (43% white and 55% black). While nearly 60% of the students at the seventh grade level were eligible for full federal lunch program assistance, a mixture of middle income and lower-upper level income families were also represented in the student body.

Parent occupations for students participating in the study were approximately 30% professional, 40% industrial and 30% agricultural in distribution. On standardized tests in reading and mathematics, students from this school system, as a whole, ranked near the 75th percentile relative to state norms. On national norms, however, the students ranked near average in reading and above average in mathematics. Approximately 65% of the students who graduate from high school in this system are expected to continue their education at the college level. When students from the middle school advance to high school, they will elect to enter either programs of study designated as college preparatory, vocational education, or general education. Even though programs in vocational education are well developed in the school system, approximately one half of the group electing vocational studies in high school generally continue their studies at the post-secondary level.

Relative to the science curriculum at the middle school level, major emphasis is placed on biological science during the seventh grade and earth science in the eighth grade. Science classes are

generally taught in the traditional manner with minimum emphasis placed on laboratory work. Teachers are professionally certified in Mississippi to teach general science. During the time of the study, science in the seventh grade was taught by two females and one male instructor. Eighth grade instruction was conducted by one male nad one female teacher.

Subjects

During the first and second years of the project, the superintendent of the district sent out a letter to the parents of the students informing them of the district's participation in this project and asking them for consent for their child's participation. The overwhelming majority of parents consented and some sections of the science classes had 100% participation. The following is a description of the student population each year of the study.

Subjects for the first year of the study consisted of 175 early adolescents enrolled in the seventh grade during the year of 1979-1980. This group was composed of 46.3% females and 53.7% males. The racial composition of the group was 41.1% white and 58.9% black. More than half the group (62.9%) were eligible for full free lunch programs, which only 28.0% came from families whose income level was too high to make them eligible for at least lunch subsidies. Students ranged in age from 12 to 15 years, with 78.3% of the group being 12 years old and 19.4% being 13 years old.

Family sizes for the groups ranged from small to very large. Thirty percent of the group had no brothers and 26.3% had no sisters. One sister and one brother were in the homes of 34.3% and 29.1% of the

group, respectively. Thirty-seven percent of the seventh graders had from 2-4 brothers and 38.8% of the group had this same number of sisters. Over 12% of the group had five or more sisters, while nearly 6% had five or more brothers.

Relative to parental occupations, 22.3% of the subjects' fathers worked in semi-skilled or unskilled jobs while 14.3$ of the mothers held comparable work positions. Low management positions (quality control specialists, supervisors) were held by 7.4% of the fathers and 1.7% of the mothers. Middle management or top management positions were held by 2.3% of the fathers and 0.6% of the mothers. Professional positions were held by 4.0% of the fathers and 7.4% of the mothers. Over 41% of the fathers and 61% of the mothers either did not work or held positions that were unknown or undetermined.

Only 2.3% of the fathers and 0.67% of the mothers had scientifically oriented careers. Nearly one-fifth of the seventh graders (18.5% females and 19.2% males), however, expressed interest in scientific careers for themselves.

In the second year, 190 students enrolled in eighth grade science classes participated in the study. This group, composed of 46.8% females and 53.2% males held approximately the same racial distribution (40.5% whites and 59.5% blacks). As expected, the students were older with 77.9% being 13 years of age, 20.0% being 14 years old, and only .1.6% 15 years or older. As expected, data reported on other demographic and personal variables in the eighth grade were similar to that of these subjects in the seventh grade.

At the end of the eighth grade, 26.9% of the group elected to take a course in general science. The rest of the group elected courses in

agriculture, home economics, art or Spanish instead of science. Nearly two-thirds of the group (63.2%) scheduled a course in general mathematics while 36.8% elected to study algebra.

Because of the longitudinal nature of this research study, only matched cases of subjects were used for the data analyses. This included 155 subjects who participated for the two years of the study. Of this group, 48% were females, 52% were males; and 39% were white, 61% were black.

Instruments

A battery of instruments were employed for collecting data relevant to student achievement, attitudes, aptitudes, and classroom interaction. Six of these instruments were developed by the investigators and copies are included in Appendix B. The other instruments were standardized batteries, tests developed by other researchers, and data available from school sources (e.g., California Achievement Test Battery). The total battery of instruments used in this study included the:

1. Developing Cognitive Abilities Test, a test of aptitude measuring verbal, spatial and quantitative skills (Beggs and Mouw, 1980).
2. Cooperative Science Test: General Science, a test of achievement in science (Educational Testing Service).
3. Science Opinionnaire, a scale measuring attitudes toward science (Fisher, 1973).
4. Affective Perception Inventory, measures of attitudes toward self concept, and self concept in science and

mathematics (Soares & Soares, 1977).

5. Elementary Sex-Role Inventory, a measure of masculinity and femininity for adolescents (Thomas & Robinson, 1980).
6. Survey of School Opinion, a measure of self in school (Kilbane, 1972).
7. Science Participation Scale, a measure of stereotyped attitudes toward participating in science.
8. Career Appropriateness Scale, an instrument about attitudes toward traditional and nontraditional careers in science.
9. Who Would You Ask for Advice, a significant others inventory relating to influences in pursuing science.
10. Parental Influences and Career Plans Questionnaire, a scale designed to measure parental influences toward careers, courses, and activities relative to science; and students' planned science and math pursuits.
11. Science Sociogram, a sociogram to measure peers' influence in science.
12. A classroom interaction/analysis plan to measure instructional and social influences in the classroom.
13. Background data collected from the students, which included information on parental occupations and number of brothers and sisters.
14. Background data collected by the teachers from the school's cumulative folders on each student, which included scores from the California Achievement Test battery, attendance, grades, and socioeconomic status.

The instruments are described in the following sections.

The Developing Cognitive Abilities Test

The Developing Cognitive Abilities Test (Form 7/8A) was used for assessing the general academic aptitude of subjects. According to its authors, the DCAT is based upon Bloom's taxonomy (Bloom et al., 1956) of educational objectives in the cognitive domain. It measures students' learning characteristics and abilities that contribute to academic performance. The test measures three dimensions of cognitive abilities: (a) verbal, (b) quantitative, and (c) spatial, as well as a total score of cognitive abilities. The 80 items for the tests are structured into Bloom's levels of cognitive development according to the following distribution: 18.8% of the items related to the level of knowledge; 25% of the items measure comprehension and application; 18.7% of the items measure skills in analysis; and 15% of the items measure skills in synthesis.

The authors (Beggs, Note 1) cited split-half reliabilities of the subtests for the DCAT as follows: for grade seven- verbal, .85; quantitative, .74; spatial, .75; for grade eight - verbal, .90; quantitative, .85; spatial, .80.

The Cooperative Science Test: General Science

The Cooperative Science Test: General Science (CST), Form B, was chosen to assess overall achievement in science since its objectives correlate most nearly with the subject matter core emphasized in the traditional junior high school programs (i.e., biological, earth, and physical science). Since the site for the study was a middle school where the traditionally-styled content orientation (as contrasted to

process base) is emphasized in the science curriculum, the CST was determined to be an appropriate measure of student achievement in science for the adolescent group studied. Developed by the Educational Testing Service in 1965, the test is judged by reviewers to have substantial validity (Buros, 1972). Moreover, approximately one-half of its questions relate to higher levels of knowledge usage, such as application, analysis, and evaluation.

Total test reliabilities as determined by using the Kuder-Richardson Formula 20 are as follows: seventh grade, .90; eighth grade, .90; and ninth grade, .92 (Handbook Cooperative Science Tests, 1964).

The Science Opinionnaire

The Science Opinionnaire (SO) was developed by Fisher (1973). It consists of 20 items designed on a Likert-type format which elicits students' opinions regarding their interests and that of their best friends in reading science, doing experiments, or relating science to other studies and to future work activities, and solving problems. It was developed specifically for the junior high school age. According to Fisher (1973) it has proved to be useful in discriminating between groups of students. Split-half reliability of the instrument was reported by Fisher to be .82. In a Mississippi sample the internal consistency of the Science Opinionnaire as computed by an alpha coefficient was found to be .95.

The Affective Perception Inventory

The Affective Perception Inventory (API) was developed by Soares and Soares (1977) to measure students' concept in a school setting.

Factor analytic studies according to the authors of the API have yielded nine dimensions of self-reported student behavior. The major factor of the instrument was characterized as describing the students' overall self concept in school. Other subscales depicted dimensions of self concept related to specific subject areas, of which one was science and another mathematics. This instrument was chosen since it assesses self concept in the school setting and also allows the student to describe his or her perceptions of self specifically in relationship to science.

Three scales of Form 1 of the API were employed to measure variables for use in this study. They were: (a) self concept, (b) mathematic perceptions, and (c) science perceptions. Alpha coefficients as measures of internal consistencies with a Mississippi sample for those three scales were found to be .95, .96, and .92, respectively. The overall alpha coefficient for the three scales of the API was .98.

Survey of Pupil Opinion

The Survey of Pupil Opinion (SURPO), developed by Kilbane (1972) and validated by Handley (1975) on a Mississippi population, was selected for use in measuring students' concept of self in school. This instrument dimensions student perceptions into three factors: (a) perception of self-as-student, (b) perception of teacher; and (c) social perceptions. In test-retest studies where 42 adolescents were requested to respond twice to the instrument with a one week time interval between responses, the following reliability coefficients were noted: Factor I, $r = .78$; Factor II, $r = .86$; Factor III, $r = .69$; Overall score, $r = .82$. In validation studies of the SURPO,

Handley (1975) found the subscales of the instrument to correlate modestly with grade point averages of students (.21 to .41), overall self concept as measured by Fitts' (1964) Tennessee Self Concept Scale (.43 to .76) and school attendance (.27 to .39).

The Elementary Sex-Role Inventory

Thomas and Robinson (1980) modified the Sex-Role Inventory, developed by Bem (1974), to measure self concepts of traditional "masculinity", "femininity" and psychological androgyny of junior high school age students. The resulting instrument, the Elementary Sex-Role Inventory (since retitled by the authors to the Adolescent Sex-Role Inventory), was used in this study to assess the adolescents' perceptions of the masculine-feminine traits according to traditional sex type roles. According to its authors, internal consistency reliability coefficients for the subscales of the ESRI range from .71 to .86.

The Science Participation Scale

The Science Participation Scale (SPS), developed and validated by the research team, was employed to measure attitudes of the subjects toward males and females participating in science activities (see Appendix A). This instrument consists of 49 statements to which subjects respond on a five-point Likert-type scale. By their response they indicate whether they "strongly agree", "agree", "don't know", "disagree", or "strongly disagree" with each given statement. The statements were designed to characterize male or female students as participants in science activities. Selected activities included in the SPS were: Academic achievement in science and mathematics; Participation in experiments; Class leadership roles; Class discussion; Teacher

directed activities; Writing reports; and General interests in science. Results from the Bem studies (1974), which identified personal traits which had historically characterized stereotyped male and female behaviors, were employed in structuring the items. For example, males are classified as more independent, aggressive, ambitious and analytical. Females are yielding, understanding, tender and helpful. The resulting items consisted of statements featuring both males and females in both stereotyped and androgynous roles relative to the study of science.

Initially, 120 items were structured. In field studies, responses from 274 junior high school age students enrolled in schools in northeastern Mississippi and north central Alabama were secured. From this sample a principal component factor analysis with orthogonal rotation (Dixon, 1975) was employed to reduce the number of items to 49. This analysis indicated that approximately 92% of the total variance associated with the student's responses to all 120 items was predicted by the 49 items. Six factors have been identified for this instrument in relationship to science activities through the use of image analysis, using an oblique rotation, which was computed by Kaiser's second-generation "Little Jiffy" program, described by Dixon (1975). The factors are: (1) Male dominance-ability/leadership/achievement; (2) Male assertiveness, female empathy; (3) Male willingness to take risks in science; (4) Male inquisitiveness; (5) Male expectations relative to science; and (6) Males active/females passive (Handley, Morse and Upshur, 1980).

The resulting six factors were derived from 44.3% of the commonality found in the response to the 49 items. The most dominant factor,

Factor 1, explaining 17.3% of the variance derived from the factor analysis, was termed "Male dominance-ability/leadership/achievement." Items in this factor looked toward the students' viewing males as demonstrating a more superior performance in science activities with a cognitive base. Males' behavior in assuming more leadership capacities in science classes as viewed by the adolescent group was also measured by this factor. The second factor, which explained approximately 11% of the variance in the factor analysis was named "Male assertiveness/female empathy and hard work." In this factor the adolescent group described a set of behaviors wherein males were viewed generally as more assertive in science activities, except for areas of empathy, human relationships and careful study preparation. In these areas, female activities looked highest.

The third factor describing the adolescents' view of males, more willingness to take risks, predicted about 5% of the variance in the factor analysis model. In this factor, as described by items on the SPS, males were seen as being more willing to dissect animals, to give blood samples for study and more likely to try out new ideas than were females.

The fourth factor, which appeared to be associated with traits of inquiry and inquisitiveness, characterized males as being more able to figure out new and better ways to do things than girls. This factor also loaded with students' perceptions of teachers helping boys with science more than girls, with boys asking more questions in class and with boys getting to do more in science classes than girls. This fourth factor was associated with 5% of the commonality variance in the factor analysis.

The fifth factor, explaining 3% of the common variance, assessed higher expectations for male students toward career goals and development of activities in science. Though this factor characterized males as having higher expectations, it also included an element of female persistence.

The sixth factor, also associated with 3% of the variance in the factor analysis, appeared to describe a general stereotype of activities in which males assumed an active role and females took a more passive role.

Alpha coefficients, measuring internal consistency for the six factors, ranged from .92 to .96.

The Career Appropriateness Scale

The Career Appropriateness Scale (CAS), developed and validated by the research team, was designed to measure attitudes of the subjects concerning the appropriateness of science-related careers for males and females. The instrument consists of 22 science-related career choices. Thirteen of the career choices were documented by the U.S. Department of Labor (1979) to be careers in which a high percentage of males were employed. Six of the career choices represent a high percentage of female employees, and two were equally represented by both genders. For each of the career choices, subjects respond to a dichotomous yes-no scale for marking whether girls or boys should or should not consider each career as a possible career choice (see Appendix A).

Analyses of the CAS show that the students who responded felt that some science-related careers are more appropriate for boys, some careers

are more appropriate for girls and others are appropriate for both genders. The careers which were indicated to be more appropriate for boys are careers still highly dominated by males and are held to be more stereotypical for men, such as electrician, engineer, electronics technician, forester, dentist and astronaut. The careers which were indicated to be more appropriate for girls are careers also highly dominated by females and are also stereotypical for women, such as dietician, librarian (science), nurse and medical secretary.

Alpha coefficient reliabilities for two subscales of this instrument were established in a pilot study. The career appropriateness for males scale had an internal consistency reliability of .93 and the career appropriateness for females scale had an internal consistency reliability of .91.

The Significant Others Inventory

Who Would You Ask for Advice? (SOI), an inventory about significant others, was constructed by the investigators to measure perceptions of subjects regarding the influence of others in the development of early adolescents' interests in science (see Appendix A). Studies by Brandwein (1952), Chambers (1964), and Handley (1966) have identified the role of adults who serve as significant others as being parents, teachers and older friends, such as scientists. As projected in the rationale for this study, it was hypothesized that peer groups, both male and female, will be influential upon the attitudes of adolescents toward science. This hypothesis is supported by the work of Entwisle and Greenberger (1970), Fennema and Sherman (1977), Cohen and Cohen (1980), and Otto (1970).

The SOI consists of nine subscales--a father scale, a mother scale, a teacher scale, a school counselor scale, a male peer scale, a female peer scale, a brother scale, a sister scale and an adult friend scale--to measure subjects' perceptions of these individuals' influence upon their science interests and activities (see Appendix A). Each classification of these nine potential significant others is paired with every other significant other group in the instrument. The result is that 36 potential pairings of significant other groups is presented in the SOI. Subjects are asked to select one group of significant others from each of the 36 paired groups who would help them most in deciding whether to take an advanced class in science during high school. In scoring the instrument, a count of the number of times each significant other entity is chosen by the subject in this forced choice process was deemed as a measure of that significant other's influence upon the adolescent's science activities.

The SOI was pilot tested and validated for use with a sample of 272 junior high school students prior to use in the study. An internal consistency reliability coefficient (alpha) of .98 was calculated for the scale.

The Parental Influences and Career Plans Questionnaire

The Parental Influences and Career Plans Questionnaire (PICP-Q), was devised by the investigators to assess early adolescents' perceptions of parental encouragement to pursue science-related careers, of parental influences on taking science and mathematics courses, parental encouragement of activities which might be related to the adolescents' daily lives, and of adolescents' future plans (see Appendix A).

For the first three scales, each set of items had a stem which asked how the student's father would feel about the specified: (a) career; (b) subject (science or math course); or (c) activity as appropriate for the adolescent's participation. This stem was followed by a Likert-type scale in which perceived father support was rated on a five-point scale with "5" indicating that the father would be "very encouraging" and the "1" meaning that the father was viewed as being "very discouraging" in supporting the career choice, election of courses in science and mathematics and everyday activities for the adolescent. The everyday activities included in the instrument were a selection of experiences which would measure attitudes toward the males and females participating in stereotyped appropriate "masculine" and "feminine" activities, as well as in activities generally considered appropriate for both sexes.

A parallel mother scale was also developed in the PICP-Q to assess adolescents' perceptions of their mother's attitudes toward careers, courses of study and appropriate everyday activities for their sons or daughters.

The final set of items, involving future plans of the young adolescents, assessed their interests in careers in mathematics and science and in courses needed for preparation in these areas. Plans for future education were documented, as well as the perceptions of parental encouragement toward career development.

Alpha coefficients were computed for the six subscales describing perceived parental support relative to career choices, choices of courses of study in science and mathematics and suitability of everyday activities for males and females. Internal consistency reliabilities

for these six subscales ranged from .89 to .95.

The Science Sociogram

The Science Sociogram (SOS) was developed by the investigators to determine social relationships within class structure (see Appendix A). A sociogram format was utilized for structuring this instrument. Students were asked to name their ideal best friends, real best friends and the person whom they would pick to work on a science project or experiment from the class. In analyzing these data, it is possible to rate the social acceptance of students of both sexes who are recognized as having scientific interests. This scale is a modification of the measurement concept reported by Justman (1953) for assessing the overall social status of all subjects within the classroom group.

On this scale, the number of times an individual in the class is named by the peer group is considered a measure of his or her social acceptance. The three measures of ideal best friend, real best friend and person whom they would pick to work on a science project or experiment were considered as separate measures in this study.

The Classroom Interaction/Observation Plan

The observation system was designed by the project investigators to be used in a structured, traditional classroom setting. The only equipment required was two tape recorders and seating charts with the students' identification numbers. Each student was assigned a four-digit identification number which was used throughout the six observations (three for the first year, three for the second year). Each observation session, which lasted thirty minutes, was taped and transcribed after the session. Using the seating chart, the observer would

code in each time a student was the recipient or originator of an interaction. These seating charts and lists of interactions for each student were then keyed back to the transcript made of the session. Once these interactions were identified on the transcript, the interaction could be analyzed.

In this study, an interaction was defined as any verbal response uttered by the student.

Each interaction was then analyzed using eight descriptive categories. These categories sought to identify and describe the speaker and various components of the interaction. Descriptions of the categories are as follows:

Category 1. Source of interaction. This category identified the origin of the verbal interaction. The three possible origins of interaction were:

1. Initiation by the teacher towards the student

   Example: Teacher asks student a question.

2. Initiation by the student towards the teacher

   Example: Student asks teacher a question.

3. Initiation by a student towards another student

   Example: Tom asks Mark for a pencil.

Category 2. Type of interaction. Each interaction was identified as one of seven types:

1. Direct questions

   Example: What is a spectroscope?

2. Class business (a noninstructional interaction)

   Example: Did you bring an excuse today?

3. Disciplinary (a noninstructional interaction)

Example: Get quiet!

4. Social (a noninstructional interaction)

Example: How are you feeling?

5. Call out to indirect questions. This interaction occurs when a student shouts out an answer to a question when the question was not directed specifically to him or her.

6. Unsolicited responses. This interaction involves volunteering additional information. It can be either instructional (e.g., the student shouting out an example) or noninstructional (e.g., the student shouting out, "I know!")

7. Solicited responses.

Example: The teacher asks the student to read from a book or read from the answers to homework questions found in the book.

Category 3. Feedback. This category describes a teacher's response to a student's answer or comment. There are ten types of teacher feedback:

1. The teacher makes no attempt to acknowledge the student's comment.

2. The teacher responds with a yes or no.

3. The teacher responds yes, followed by restating the student's answer or responds by restating the question.

4. The teacher responds with an acknowledgment and then proceeds to give a prompt, hint or cue to help the student expand the response (e.g., "Yes, but what about the leaves on the Magnolia?" or "No, it starts with an 's'.")

5. The teacher acknowledges the student and then adds a statement

of praise about the response (e.g., "That's right. Good.")

6. The teacher asks for clarification. It could be to clarify who is speaking or to clarify exactly what was said (e.g., "Who said lava?" or "Speak up.")

7. The teacher gives the answer to his or her own question.

8. The teacher responds with a critical comment (e.g., "That's not being very smart.")

9. The teacher elaborates on a particular response made by a student. This expansion adds a lot more information or explanation in depth on a particular point without covering new material.

10. The teacher responds to a question raised by a student.

Category 4. Instructional question. In this category, the question asked by the teacher or student is identified as being either instructional or noninstructional.

Example of an instructional question: "Where are the male reproductive organs located in a plant?"

Example of a noninstructional question: "Do we get to take our scoliosis forms to the office?"

Category 5. Domain of instructional question. This category identified the cognitive skill required of the student in answering the teacher's question. Five domains of learning were used to classify the questions (Gagné, 1977).

1. Information. The student is required to recall facts, labels, names or other rote information.

Example: "What is the definition of pistil?"

2. Intellectual skills. The student is required to make discriminations, identify concepts and apply rules.

Example: Solve an equation.

3. Cognitive strategies. The student is required to respond with original solutions to problems.

Example: Generation of a creative and novel solution to a problem.

4. Attitudes. The behavior involved in this domain involves attitudes reflecting choice or feeling.

Example: "What do you think of when you see a tulip?"

5. Psychomotor. The student is required to demonstrate a motor skill.

Example: Perform a laboratory sequence requiring hand-eye coordination.

Category 6. Correctness of answers. This category assessed the correctness of a student's response. The three choices were: (a) incorrect; (b) correct; and (c) partially correct.

Category 7. Wait-times. Wait-time refers to the amount of time that lapses between interacting sources. In this study, two wait-times were measured. The first was student response time, which is the length of time it takes for the student to respond to the teacher. The second, called teacher wait-time, is the length of time it takes for the teacher to give feedback to the student's response. These times were measured using a stop watch and calculated to the nearest one-hundredth of a second.

For each interaction, each of these categories was analyzed. The categories are summarized in Table 1 .

For the purposes of this study, this information was collapsed into total number of instances of each category for each student. The interactions, and their subsequent qualifiers, were aggregated across

Table 1

Summary of Information Coded on Interactions

Category	Levels within Category
Source of Interaction	Teacher to Student Student to Teacher Student to Student
Type of Interaction	Direct question Class business Disciplinary Social Call out to Indirect Question Unsolicited Response Solicited Response
Feedback	None Simple acknowledgment Restate answer/question Prompt Praise Clarification Correction Criticism or disciplinary Elaboration Teacher's answer to Student's question
Instructional Question	Yes or No
Domain of Question	Information Intellectual Skills Cognitive Strategies Attitudes Psychomotor
Correctness	Incorrect Correct Partially correct
Student Response Time	Recorded in seconds and hundredths of seconds
Teacher Wait Time	Recorded in seconds and hundredths of seconds

the three occasions for each year for each student, so that each of the participants had a summed frequency of occurrence for each observation category. The only exceptions were for student response time and teacher wait-time, which were averaged.

The inter-rater agreement (percent averaged across categories) was .82 for the observations.

California Achievement Test Battery

Students' achievement scores in the areas of mathematics, reading and language arts as measured by form C of the California Achievement Test (CAT) battery, were available in their academic records. In addition, the Short Form Test of Academic Aptitude (SFTAA) scores were available. The achievement data were also utilized as cognitive variables in this study. Test-retest reliabilities for the CAT scores used were as follows: Seventh grade--Total reading, .86; Total language, .86; and Total mathematics, .81; Eighth grade--Total reading, .85; Total Language, .84; and Total mathematics, .83 (California Achievement Tests, 1979).

RESULTS AND DISCUSSION

Research Questions One and Two

The following questions were posed about the influences of teachers and peers within the context of classroom observations.

1. What differences in classroom interactions are observed for male and female students in the science classroom relative to teacher-student interactions and peer-student interactions, respectively?

2. Are there differences in the domains of learning expected by teachers of male and female students as indicated by the types of questions asked of the students?

Seventh grade

During the first year of the study, while the students were enrolled in the seventh grade, a total of 1802 interactions between teacher-student, student-teacher, or student-student (i.e. peer-peer) were recorded. Table 2, Summary of Observation Results across all Three occasions for year one, presents frequencies for each of the categories of observation data collected. For each source of interactions, males either received or initiated more interactions that did females. Males received nearly one-third more interactions from the teacher than did females and initiated nearly one-fourth more interactions with the teacher than did the male students. Very few interactions between peers were recorded from either sex, although the males had more instances in this category than did the females. Unfortunately, since many peer-peer interactions are non-verbal or are whisper quiet, these interactions were not available from this observational system. Additionally, due to the very traditional structure of the classrooms that were observed in this study, peer-

peer interactions were not encouraged. These conditions partially reflect why there is a paucity of data in the student-student category.

With the exception of solicited responses, males in the seventh grade received more of the different types of interaction than did girls. Males received or initiated more direct questions, more interactions relating to classroom business, more disciplinary or social interactions, call-outs and unsolicited responses than did females. Females had more instances of solicited responses. The category of solicited response often was the result of prepared material the student had been asked to bring to class rather than a spontaneous verbal dialogue.

Females and males in this first year fared differently as to the kinds of feedback they received within interactions. There were more instances where males received no feedback or simple acknowledgment than did females, but males also had more instances of structured feedback such as restatement of question/answer, prompting, clarifications, corrections, or elaborations. Females received slightly more praise than males, although the total number of instances was very low for either gender.

Although each instructional question was examined for the domain of learning that it reflected, only two domains were represented: information and attitudes. The instructional questions asked by the teachers in this study relied heavily upon verbal information that required the student to name, to label, or to remember simple facts. Although concepts and rules were discussed, the questions posed by the teacher required the student to respond to verbal information <u>about</u> the

Table 2

Summary of Observation Results
Across All Three Observations
for Year 1: Seventh Grade

Variable	Group	Totals	Mean	Standard Deviation	N
Source of interaction: teacher-student	Females	637	8.49	6.36	75
	Males	860	10.75	7.45	80
	Totals	1497	9.66	7.45	155
Source of interaction: student-teacher	Females	120	1.60	2.52	75
	Males	176	2.20	3.70	80
	Totals	296	1.91	3.19	155
Source of interaction: student-student	Females	3	.040	.20	75
	Males	6	.075	.35	80
	Totals	9	.058	.29	155
Type of interaction: direct question	Females	455	6.07	6.28	75
	Males	669	8.36	7.10	80
	Totals	1124	7.25	6.79	155
Type of interaction: class business	Females	38	.620	1.30	75
	Males	57	.510	2.05	80
	Totals	95	.720	1.72	155
Type of interaction: disciplinary	Females	4	.06	.280	75
	Males	5	.06	.332	80
	Totals	9	.06	.307	155
Type of interaction: social	Females	12	.16	.55	75
	Males	15	.19	.53	80
	Totals	27	.17	.54	155

Table 2

Summary of Observation Results
Across All Three Observations
for Year 1: Seventh Grade
(continued)

Variable	Group	Totals	Mean	Standard Deviation	N
Type of interaction: call outs to indirect questions	Females	81	1.08	2.17	75
	Males	177	2.21	3.15	80
	Totals	258	1.67	2.77	155
Type of interaction: unsolicited response	Females	7	.09	.50	75
	Males	9	.11	.32	80
	Totals	16	.10	.41	155
Type of interaction: solicited response	Females	162	2.16	3.42	75
	Males	110	1.38	2.65	80
	Totals	272	1.76	3.07	155
Feedback: None	Females	105	1.40	1.68	75
	Males	164	2.05	2.26	80
	Totals	269	1.74	2.02	155
Feedback: simple acknowledgment	Females	128	1.71	1.59	75
	Males	180	2.25	1.89	80
	Totals	308	1.99	1.77	155
Feedback: restate answer/ question	Females	227	3.03	2.66	75
	Males	301	3.76	3.42	80
	Totals	528	3.41	3.09	155
Feedback: Prompt	Females	107	1.43	2.11	75
	Males	159	1.99	2.38	80
	Totals	266	1.72	2.26	155

Table 2

Summary of Observation Results
Across All Three Observations
for Year 1: Seventh Grade
(continued)

Variable	Group	Totals	Mean	Standard Deviation	N
Feedback: praise	Females	9	.12	.37	73
	Males	7	.09	.48	82
	Totals	16	.10	.43	155
Feedback: clarification	Females	77	1.03	1.36	75
	Males	80	1.00	1.26	80
	Totals	157	1.01	1.30	155
Feedback: corrections	Females	41	.55	1.06	75
	Males	54	.68	1.27	80
	Totals	95	.61	1.17	155
Feedback: criticism or disciplinary	Females	17	.22	.58	75
	Males	19	.24	.58	80
	Totals	36	.23	.58	155
Feedback: elaboration	Females	10	.13	.38	75
	Males	23	.29	.62	80
	Totals	33	.21	.52	155
Feedback: teacher's answer to student question	Females	39	.52	1.27	75
	Males	55	.69	2.04	80
	Totals	94	.61	1.71	155
Domain of instructional question: information	Females	540	7.20	7.79	75
	Males	803	10.04	9.38	80
	Totals	1343	8.66	8.74	155

Table 2

Summary of Observation Results
Across All Three Observations
for Year 1: Seventh Grade
(continued)

Variable	Group	Totals	Mean	Standard Deviation	N
Domain of instructional question: intellectual skills	Females	0	0.0	0.00	0
	Males	0	0.0	0.00	0
	Totals	0	0.0	0.00	0
Domain of instructional question: cognitive strategies	Females	0	0.00	0.00	0
	Males	0	0.00	0.00	0
	Totals	0	0.00	0.00	0
Domain of instructional question: attitudes	Females	0	0.000	0.00	75
	Males	8	1.000	0.79	80
	Totals	8	.052	0.57	155
Domain of instructional question: psychomotor	Females	0	0.00	0.00	0
	Males	0	0.00	0.00	0
	Totals	0	0.00	0.00	0
Student response time	Females	--	1.89	1.12	75
	Males	--	1.79	0.91	80
Teacher wait time	Females	--	1.91	1.57	75
	Males	--	1.87	0.99	80
Correctness of response: incorrect	Females	373	4.97	5.30	75
	Males	486	6.08	6.04	80
	Totals	859	5.54	5.71	155

Table 2

Summary of Observation Results
Across All Three Observations
for Year 1: Seventh Grade
(continued)

Variable	Group	Totals	Mean	Standard Deviation	N
Correctness of response: correct	Females	315	4.20	3.13	75
	Males	459	5.74	4.17	80
	Totals	774	4.99	3.91	155
Correctness of response: partially correct	Females	72	0.96	1.67	75
	Males	97	1.21	1.63	80
	Totals	169	1.09	1.65	155

Table 3

Summary of T-Test Results on
Observation Data: Seventh Grade

Variable	Group	Number of Cases	Mean	Standard Deviation	T Value	df	Probability
Total number of interactions across all three observations	Females	75	10.13	7.72	-2.07	153	.040*
	Males	80	13.03	9.52			
Total number of instructional questions	Females	75	9.93	7.73	-2.19	153	.030*
	Males	80	13.00	9.52			
Student response time (seconds)	Females	75	1.89	1.12	.60	153	.551
	Males	80	1.79	.91			
Teacher wait time (seconds)	Females	75	1.91	1.57	.71	153	.861
	Males	80	1.87	.99			
No response to teachers' questions	Females	75	2.27	3.12	-.07	153	.942
	Males	80	2.30	2.53			

*Significant at $\alpha = .05$.

concept, rather than identify examples or characteristics of the concept, or to apply rules. Even with this limitation, males were asked more information and attitude questions.

Females in the study during the seventh grade were slower to respond to female students than male students.

Additionally, males answered more questions (in all categories: incorrectly, correctly, or partially correct) than did females. This is due, in part, to the fact that they were asked more questions.

Table 3 presents the results of t-tests conducted using the following dependent variables: (a) total number of interactions across all three observations, (b) total number of instructional questions, (c) student response time, (d) teacher wait-time, and (e) frequency of no response to teacher questions. a significant difference (at the .05 level) was observed between males and females on the total number of interactions over the three occasions for the first year. The difference came to nearly one more interaction per period for males than for females (i.e. 13.03 as compared to 10.13). Similarly, male students were observed to have been asked significantly more instructional questions than did female students. The difference was, on the average, about one more question per period with males asked an average of 13.00 instructional questions and females asked an average of 9.93 instructional questions. The differences on the student response times and teacher wait-times were negligible and were not significantly different. This was also true for the variable of no response to teachers' questions.

The next set of analyses was five chi-square tests of independence using student gender and the full set of levels within categories for the following variables:

1. Source of interaction
    - Teacher to student
    - Student to teacher
    - Student to student
2. Type of interaction
    - Direct question
    - Class business
    - Disciplinary
    - Social
    - Call out to indirect question
    - Unsolicited response
    - Solicited response
3. Feedback
    - None
    - Simple acknowledgment
    - Restate answer/question
    - Prompt
    - Praise
    - Clarification
    - Correction
    - Criticism or disciplinary
    - Elaboration
    - Teacher's answer to student's question
4. Domains of Learning
    - Information
    - Intellectual skills
    - Cognitive strategies

Attitudes

Psychomotor

5. Correctness

Incorrect

Correct

Partially correct

The results of these chi-square tests are presented in Table 4. Significant (at the .05 level) chi-squared values were obtained for the variables type of interaction and domains. No significant differences were observed for the variables of source of interaction, type of interaction, feedback types, or for the correctness of the response.

Discriminant analyses, using the observation variables as the independent variates, were completed for three different sets of criterion groups: gender groups, race groups, and gender and race groups. The results of the analyses are presented in the same order. In each analysis, a stepwise approach was used with the dual criterion for entry of a variable having a statistically significant F-ratio for entry and reducing the cumulative Wilks' lambda by at least .01.

The first discriminant analysis, attempting to predict gender group, is summarized in Table 5 . Only four of the observation variables entered in the only significant function, which yielded an overall Wilks' lambda of .920, and a canonical correlation of discriminant function scores with gender groups of .282. In order of magnitude of standardized coefficients, the selected variables were call-outs to indirect questions, simple acknowledgment, elaboratives and clarification. This function was capable of classifying 60% of

Table 4

Summary of Chi-Square Calculations
for Selected Contrasts by Gender for 7th Grade

Contrast	χ^2	df	Probability
Source of interaction	.6999	2	p = .7101
Type of interaction	47.6066	6	p < .0001*
Feedback types	11.5194	9	p = .2413
Domains[1]	5.3585	1	p = .0195*
Correctness of response	1.2536	2	p = .5393

[1]Although there are five possible domains, only 2 types appeared in the interactions (i.e., information and attitudes).

*Significant at α = .05.

Table 5

Summary of Discriminant Functions for Gender Groups: Year 1 Observation Data

Entry	Discriminant Function Variables[1]	Standardized Coefficients	Directionality	Cumulative Wilks' Lambda	Chi-Squared	df	Probability
1	Type of interaction: call outs to indirect questions	.702	M > F	.958	12.524	4	.0138*
2	Feedback: elaboration	.553	M > F	.936			
3	Feedback: clarification	-.442	M > F	.928			
4	Feedback: simple acknowledgment	.554	M > F	.920			

[1]Order of variables reflects order of first significant function only.

*Significant at $\alpha = .05$.

the students correctly by gender. The accuracy of classification was higher for females than for male students.

The second discriminant analysis used race groups as the criterion variable. A total of seven of the observation variables met the dual criterion described above. The sole discriminant function yielded an overall Wilks' lambda of .863 and an overall canonical correlation of discriminant function scores with race group membership of .370. In order of magnitude of standardized function coefficients, the variables were: (a) number of instructional questions asked, (b) correctness of response, (c) student-to-teacher interactions, (d) call-outs to indirect questions, (e) no response to questions, (f) no feedback, and (g) praise (see Table 6). This function could classify about 63% of the students in the seventh grade correctly by race. Classification was more accurate for white students than for black students (i.e., 73.3% vs. 56.4%, see Table 8).

The third analysis using the four combinations of race and gender as the criterion groups, yielded two independent discriminant functions which were statistically significant at the .05 level. These are summarized in Table 7. The first discriminant function yielded an overall Wilks' lambda of .734. The overall canonical correlations for the two functions were .380 and .334 for the first and second, respectively. A total of seven of the variables entered both functions. In order of magnitude of standardized coefficients, these variables were: (a) no responses to questions, (b) clarification, (c) call-outs to indirect questions, (d) elaborative feedback, (e) no feedback, (f) correctness of response, and (g) teacher-initiated interactions. The accuracy of classification was highest for white females students and lowest for black males. These results are summarized in Table 8.

Table 6

Summary of Discriminant Functions for Race Groups: Year 1 Observation Data

Entry	Discriminant Function Variables[1]	Standardized Coefficients	Cumulative Wilks' Lambda	Chi-Squared	df	Probability
1	Feedback: None	-.727	.937	21.853	7	.0027*
2	Source of interaction: student to teacher	-.973	.917			
3	Feedback: praise	.470	.907			
4	No response	.347	.899			
5	Type of interaction: call out to indirect question	.757	.881			
6	Correctness of response	-.989	.871			
7	Number of instructional questions asked	1.150	.862			

[1]Order of variables reflects order of entry in discriminant run.

Overall canonical correlation = .370.

*Significant at $\alpha = .05$.

Table 7

Summary of Discriminant Functions for Gender by Race Groups: Year 1 Observation Data

Entry	Discriminant Function Variables[1]	Standardized Coefficients Function 1	Standardized Coefficients Function 2	Cumulative Wilks' Lambda[2]	Function	Chi-Squared	df	Probability
1	No responses to questions	-.726	.140	.936	1	45.613	21	.0014*
2	Type of interaction: call outs to indirect questions	.420	.820	.872	2	22.590	12	.0314*
3	Feedback: elaboration	.327	.420	.835				
4	Feedback: clarification	-.623	-.115	.810				
5	Correctness of response	.285	-1.277	.782				
6	Feedback: none	.320	-.648	.760				
7	Source of interaction: teacher to student	.218	1.300	.734				

[1]Order of variables reflects order of entry for first discriminant function.

[2]Values for first discriminant function only.

Overall canonical correlation = .380 for the first discriminant function and .334 for the second discriminant function.

*Significant at $\alpha = .05$.

Table 8

Summary of Classification Rates for Discriminant Analyses for Year 1 Observation Data[1]

Group	Number of Cases	Classification	
		Correct	Incorrect
Female	75	57(76.0%)	18(24.0%)
Male	80	36(45.0%)	44(55.0%)
White	60	44(73.3%)	16(26.7%)
Black	94	53(56.4%)	41(43.6%)
White Female	28	18(64.3%)	10(35.7%)
Black Female	47	21(44.7%)	26(55.3%)
White Male	32	12(37.5%)	20(62.5%)
Black Male	47	17(36.2%)	30(63.8%)

[1]Classifications for gender and race based on first discriminant function.

Eighth Grade

During the second year of the study, a total of 2,094 interactions were observed during the three observation periods. Again, males received more teacher to student interactions than females although this difference was not as great as during the seventh grade year. For student-teacher interactions, males initiated over twice as many conversations with the teacher as did females. There were few student-student interactions for either gender group which is consistent with the nature of the highly-structured classrooms that were observed. With the exception of solicited responses, males had more instances of the different types of feedback. Of particular interest is the male domination of direct questions, class business, call-outs to indirect questions, and unsolicited responses. Although there were few instances of either disciplinary or social interactions for either gender, males again had more instances of these interactions. With the exception of praise, which was equally distributed between genders in frequency during these observations, males had higher frequencies for each kind of feedback. Males had more instances of no feedback or simple acknowledgment. For the more structured forms of feedback, both gender groups appeared to be fairly equal, but males did receive more disciplinary feedback or criticism and more elaborative feedback (see Table 9).

As was true for the seventh grade year, the teachers in the eighth grade asked questions from only two domains of learning: information and attitudes. While boys were the recipients of more information questions that were the girls, this trend was reversed for questions from the attitude domain.

Table 9

Summary of Observation Data
for Year 2: Eighth Grade

Variable	Group	Totals	Mean	Standard Deviation	N
Source of interaction: teacher-student	Females	790	11.66	6.42	75
	Males	1017	10.53	5.57	80
	Totals	1807	12.71	7.00	155
Source of interaction: student-teacher	Females	84	1.12	2.00	75
	Males	194	2.43	4.66	80
	Totals	278	1.79	3.68	155
Source of interaction: student-student	Females	5	.07	.30	75
	Males	4	.05	.27	80
	Totals	9	.06	.29	155
Type of interaction: direct question	Females	544	7.39	4.31	75
	Males	756	9.45	4.85	80
	Totals	1310	8.45	4.70	155
Type of interaction: class business	Females	5	.07	.30	75
	Males	50	.63	1.22	80
	Totals	55	.36	.94	155
Type of interaction: disciplinary	Females	2	.03	.16	75
	Males	5	.06	.24	80
	Totals	7	.05	.21	155
Type of interaction: social	Females	0	.00	.00	75
	Males	4	.05	.22	80
	Totals	4	.03	.16	155
Type of interaction: call-out to indirect questions	Females	89	1.19	1.96	75
	Males	168	2.10	3.81	80
	Total	25/	1.66	3.08	155

Table 9

Summary of Observation Data
for Year 2: Eighth Grade
(continued)

Variable	Group	Totals	Mean	Standard Deviation	N
Type of interaction: unsolicited responses	Females	22	.29	0.71	75
	Males	79	.99	2.11	80
	Totals	101	.65	1.63	155
Type of interaction: solicited responses	Females	202	2.69	2.97	75
	Males	153	1.91	2.61	80
	Totals	355		2.81	155
Feedback: None	Females	102	1.36	1.47	75
	Males	165	2.06	2.73	80
	Totals	267	1.72	2.24	155
Feedback: simple acknowledgment	Females	108	1.44	1.66	75
	Males	205	2.56	2.10	80
	Totals	313	2.02	1.98	155
Feedback: restate answer/ question	Females	402	5.36	3.62	75
	Males	469	5.86	3.76	80
	Totals	871	5.62	3.69	155
Feedback: prompt	Females	140	1.87	1.82	75
	Males	156	1.95	1.80	80
	Totals	296	1.91	1.81	155
Feedback: praise	Females	10	.13	.34	75
	Males	10	.13	.33	80
	Totals	20	.13	.34	155
Feedback: clarification	Females	36	.48	.80	75
	Males	38	.48	.80	80
	Totals	74	.48	.79	155
Feedback: correction	Females	30	.40	.59	75
	Males	35	.44	.67	80
	Totals	65	.42	.63	155

Table 9

Summary of Observation Data
for Year 2: Eighth Grade
(continued)

Variable	Group	Totals	Mean	Standard Deviation	N
Feedback: criticism or disciplinary	Females	5	.07	.30	75
	Males	32	.40	.96	80
	Totals	37	.24	.74	155
Feedback: elaboration	Females	4	.05	.23	75
	Males	11	.14	.41	80
	Totals	15	.10	.34	155
Feedback: teacher's answer to student's question	Females	40	.54	1.08	75
	Males	94	1.18	2.26	80
	Totals	134	.87	1.81	155
Domain of instructional question: information	Females	614	8.19	4.90	75
	Males	871	10.89	6.67	80
	Totals	1485	9.58	6.01	155
Domain of instructional question: intellectual skills	Females	0	0.00	0.00	0
	Males	0	0.00	0.00	0
	Totals	0	0.00	0.00	0
Domain of instructional question: cognitive strategies	Females	0	0.00	0.00	0
	Males	0	0.00	0.00	0
	Totals	0	0.00	0.00	0
Domain of instructional question: attitudes	Females	10	.13	.58	75
	Males	2	.03	.16	80
	Totals	12	.08	.42	155

Table 9

Summary of Observation Data
for Year 2: Eighth Grade
(continued)

Variable	Group	Totals	Mean	Standard Deviation	N
Domain of instructional questions: psychomotor	Females	0	0.00	0.00	0
	Males	0	0.00	0.00	0
	Totals	0	0.00	0.00	0
Student response time	Females	--	1.44	.86	75
	Males	--	1.22	.50	80
					155
Teacher wait time	Females	--	1.45	1.29	75
	Males	--	1.39	1.15	80
					155
Correctness of response: incorrect	Females	301	4.01	3.06	75
	Males	495	6.19	6.48	80
	Totals	796	5.14	5.22	155
Correctness of response: correct	Females	492	6.56	4.64	75
	Males	622	7.78	4.65	80
	Totals	1114	7.19	4.67	155
Correctness of response: partially correct	Females	84	1.12	1.71	75
	Males	97	1.21	1.36	80
	Totals	181	1.17	1.53	155

Males in the eighth grade were quicker to respond to teachers than were females and teachers were quicker to respond to them.

The eighth grade boys answered more questions (in all categories: correctly, incorrectly, or partially correct) than did the eighth grade girls. Again, this is in part due to the fact that they were asked more questions than the girls.

Table 10 presents the results of t-tests conducted using the following dependent variables: (a) total number of interactions, (b) total number of instructional questions, (c) student response time, (d) teacher wait time, and (e) no response to teachers' questions. Significant differences (at the .05 level) were found between the gender groups on total number of interactions, total number of instructional questions, and student response time. The findings for the first two variables are consistent with the seventh grade results. For total number of interactions across the three observations, the males received nearly one more interaction per observation than did the girls (i.e., 15.17 vs. 11.72). This also held true for total number of instructional questions (i.e., 14.68 vs. 11.19). For both gender groups, the students responded more quickly during the second year, with males widening the gap with quicker responses.

The results of the chi-square tests are presented in Table 11 All variables were statistically significant.

Discriminant analyses were performed on the observation variables from the second year for the three groups: (a) gender, (b) race, and (c) gender by race. The first discriminant analysis, which attempts to predict gender, is summarized in Table 12. Twelve of the observa-

Table 10

Summary of T-Test Results on Observation Data: Eighth Grade

Variable	Group	Number of Cases	Mean	Standard Deviation	T Value	df	Probability
Total number of interactions across all three observations	Females	75	11.72	6.63	-2.48	153	.014*
	Males	80	15.19	10.24			
Total number of instructional questions	Females	75	11.19	6.16	-2.63	153	.009*
	Males	80	14.68	9.80			
Student response time (seconds)	Females	75	1.44	.86	1.99	153	.048*
	Males	80	1.22	.50			
Teacher wait time (seconds)	Females	75	1.45	1.29	.34	153	.737
	Males	80	1.39	1.15			
No response to teachers' questions	Females	75	2.77	2.74	-1.65	153	.102
	Males	80	3.78	4.56			

*Significant at $\alpha = .05$.

Table 11

Summary of Chi-Square Calculations
for Selected Contrasts by Gender 8th Grade

Contrast	χ^2	df	Probability
Source of interaction	18.7206	2	p = .0002*
Type of interaction	83.0163	6	p < .0001*
Feedback types	42.6163	9	p < .0001*
Domains[1]	8.6328	1	p < .0040*
Correctness of responses	9.3144	2	p = .0096*

[1]Although there are five possible domains, only two types appeared in the interactions (i.e., information and attitudes).

*Significance at α = .05.

tion variables entered in the only significant function which yielded an overall Wilks' lambda of .739 and an overall canonical correlation of .511. In order of magnitude of standardized coefficients, the variables which characterized this function are: (a) no response, (b) correctness of response, (c) class business, (d) information questions, (e) attitude questions, (f) unsolicited responses, (g) direct questions, (h) social interactions, (i) simple acknowledgment, (j) praise, (k) attitude questions, and (l) student response time. This function was capable of classifying 72% of the students correctly by gender (see Table 15).

The second discriminant run attempted to classify the eighth graders by race using the observation data (see Table 13). There was only one significant function, and it yielded an overall Wilks' lambda of .781, and a canonical correlation of .468. In order of magnitude of standardized coefficients, the selected variables for this function were: (a) student to teacher interactions, (b) call outs to indirect questions, (c) number of instructional questions, (d) simple acknowledgment, (e) student response time, (f) praise, (g) social interactions, (h) attitude questions, and (i) class business. This function was capable of classifying nearly 69% of the cases correctly and was almost as accurate for both genders.

For the third discriminant analysis the four criterion groups of gender by race were again used (see Table 14). This analysis yielded three significant functions. These functions yielded a Wilks' lambda of .493, .700 and .862 for the first, second and third functions, respectively. Canonical correlations for these functions were .545, .434, and .371, respectively. A total of thirteen variables entered

this function. In order of magnitude of the standardize coefficient (using the first function), these variables were: (a) teacher to student interactions, (b) information question, (c) incorrectness of response, (d) no response, (e) call outs to indirect questions, (f) student response time, (g) simple acknowledgement, (h) praise, (i) criticism or disciplinary feedback, (j) social interactions, (k) class business, (l) correctness of response, and (m) attitude questions. This function was capable of classifying about 52% of the students correctly. It was less accurate for males than for females.

Table 12

Summary of Discriminant Functions for Gender Groups: Year 2 Observation Data

Entry	Discriminant Function Variables[1]	Standardized Coefficients	Directionality	Cumulative Wilks' Lambda	Chi-Squared	df	Probability
1	Type of interaction: class business	.681	M > F	.910	44.570	12	.0000*
2	Feedback: simple acknowledgment	.370	M > F	.857			
3	Type of interaction: social	.390	M > F	.834			
4	Domain of instructional question: attitudes	-.245	M < F	.818			
5	Student response time	-.231	M < F	.804			
6	Correctness of response	-.726	M > F	.792			
7	Domain of instructional question: information	.555	M > F	.784			
8	No response	-.804	M > F	.770			
9	Feedback: praise	-.297	M = F	.760			
10	Type of interaction: unsolicited response	.478	M > F	.751			
11	Feedback: clarification	-.223	M < F	.744			

Table 12

Summary of Discriminant Functions for Gender Groups: Year 2 Observation Data
(continued)

Entry	Discriminant Function Variables	Standardized Coefficients	Directionality	Cumulative Wilks' Lambda	Chi-Squared	df	Probability
12	Type of interaction: direct question	.470	M > F	.738			

[1]Order of variables reflects order of entry in discriminant run.

Overall canonical correlation = .511.

*Significant at α = .05.

Table 13

Summary of Discriminant Functions for Race Groups: Year 2 Observation Data

Entry	Discriminant Function Variables[1]	Standardized Coefficients	Cumulative Wilks' Lambda	Chi-Squared	df	Probability
1	Student response time	.591	.956	36.516	9	.0000*
2	Type of interaction: call out to indirect question	.739	.913			
3	Feedback: simple acknowledgment	-.689	.867			
4	Feedback: praise	.310	.834			
5	Source of interaction: student to teacher	-.795	.819			
6	Number of instructional questions	.703	.806			
7	Domain of instructional question: attitudes	-.252	.794			
8	Type of interaction: social	-.307	.782			
9	Type of interaction: class business	.239	.776			

[1]Order of variables reflects order of entry in discriminant run.

Overall canonical correlation = .468.

*Significant at $\alpha = .05$.

Table 14

Summary of Discriminant Functions for Gender by Race Groups: Year 2 Observation Data

Entry	Discriminant Function Variables[1]	Standardized Coefficients Function 1	Function 2	Function 3	Cumulative Wilks' Lambda[2]	Function	Chi-Squared	df	Probability
1	Type of interaction: class business	.309	.569	.202	.875	1	102.30	39	p = .0000*
2	Feedback: simple acknowledgment	.493	-.531	.937	.789	2	51.459	24	p = .0009*
3	Student response time	-.574	.219	.254	.716	3	21.355	11	p = .0299*
4	Type of interaction: call out to questions	-.581	.569	.452	.667				
5	Type of interaction: social	.317	-.169	.393	.635				
6	Feedback: praise	-.485	.012	.268	.610				
7	Domain of instructional question: attitudes	.115	-.289	-.488	.590				
8	Feedback: criticism or disciplinary	.417	.181	-.365	.573				
9	Source of interaction: teacher to student	-1.153	.559	1.576	.558				
10	Domain of instructional question: information	1.008	.537	-.554	.534				
11	Correctness of response	.139	-.505	-1.447	.521				

Table 14

Summary of Discriminant Functions for Gender by Race Groups: Year 2 Observation Data (continued)

Entry	Discriminant Function Variables	Standardized Coefficients Function 1	Function 2	Function 3	Cumulative Wilks' Lambda	Function	Chi-Squared	df	Probability
12	No response	-.722	-.555	.683	.507				
13	Incorrectness of response	.748	-.032	-1.251	.492				

[1]Order of variables reflects order of entry for first discriminant function.

[2]Values for first discriminant function only.

Overall canonical correlation = .545 for the first discriminant function, .433 for the second discriminant function, and .371 for the third discriminant function.

Table 15

Summary of Classification Rates for Discriminant Analyses for Year 2 Observation Data[1]

Group	Number of Cases	Classification	
		Correct	Incorrect
Female	75	59(78.7%)	16(21.3%)
Male	80	53(66.2%)	27(33.3%)
White	60	42(70.0%)	18(30.0%)
Black	94	64(68.1%)	30(31.9%)
White Female	28	16(57.1%)	12(42.9%)
Black Female	47	29(61.7%)	18(38.3%)
White Male	32	17(53.1%)	15(46.9%)
Black Male	47	18(38.3%)	29(61.7%)

[1]Classifications for gender and race based on first discriminant function.

Research Question Three

Research question three investigates the role of self concept and gender role relative to attitudes toward science.

Are there differences in male and female students' concepts of self and gender role relative to science interests? Separate analyses relating variables of self concept and sex-role perceptions to attitudes of students toward science in the seventh and eighth grades, respectively, indicated that as the adolescents matured, both gender groups showed higher correlations between their attitudes toward science and stereotypes in their perceptions of science as a male domain.

In analyzing data needed to answer this question, simple Pearson product-moment correlations were computed for male and female students, separately, at the seventh and eighth grade levels. Fisher r-to-z transformations were then derived to test for significant differences in the relationships of self concept/gender role identities to attitudes toward science for males and females at the separate grade levels.

The criterion variable in this analysis was considered to be overall attitudes toward science as measured by the Science Opinionnaire (SO) developed by Fisher (1973). Independent or predictor variables were the six subscales of the Science Participation Scale which measured attitudes toward male dominance in science activities, two scales of the Career Appropriateness Scale measuring perceptions of appropriateness of careers in science for males and females, three dimensions of self concept in school as assessed by the Survey of Pupil

Opinion (Kilbane, 1972) and three scales of self concept in science and mathematics, as well as general self concept, as measured by the Affective Perception Inventory (API) by Soares and Soares (1977). Resulting data for the z tests comparing the relationships between males and females at the two grade levels are given in Tables 16 and 17.

As noted on Table 16, there were no significant differences in the relationship of the self concept/gender role variables to attitudes toward science between males and females at the seventh grade level. However, significant relationships for males, as compared to females, were found between their attitudes toward science and their perceptions of appropriateness of careers in science for males, their self-as-student, self-teacher and self-social perceptions, and their self concepts in science. Significant correlations were observed between females' attitudes toward science and their self perceptions of personal traits stereotypically labeled as both masculine and feminine. Though both males and females' perceptions of males as being more assertive/females empathetic in science related negatively to their attitudes toward science, the relationship was stronger for females; i.e., the females who saw males as more assertive also had less positive attitudes toward science.

In the eighth grade, positive perceptions of self in school and self social relations for both gender groups correlated positively with attitudes toward science, the relationship was more positive for males, although the difference was not statistically significant (see Table 17).

Table 16

Simple Correlations of Self Concept and Gender Role Variables with Male and Female Seventh Graders' Attitudes toward Science

Variables	Attitudes toward Science (SO) Male r	Female r	z
Male dominance-ability/leadership/ach. (SPS)	-.12	.08	1.25
Higher male expectations (SPS)	-.07	-.26**	1.21
Males-assertiveness/females-empathy (SPS)	-.22	-.32**	0.68
Males-risktaking (SPS)	-.03	-.11	0.50
Males-Inquisitiveness (SPS)	.15	.08	0.45
Males-active/females-passive (SPS)	.12	.01	0.70
Career appropriateness-males (CAS)	.24**	-.04	1.80
Career appropriateness-females (CAS)	.18	.08	0.64
Self-as-student (SURPO)	.55**	.48**	0.59
Self-teacher perceptions (SURPO)	.49**	.24**	1.82
Self-social relations (SURPO)	.49**	.38**	0.85
Masculinity (ESRI)	.08	.31**	1.50
Femininity (ESRI)	.28**	.42**	1.00
Self concept-overall (API)	.30**	.39**	0.64
Self concept in science (API)	.65**	.50**	1.41
Self concept in mathematics (API)	.41**	.31**	0.72

**Significant at .01 level.

Table 17

Simple Correlations of Self Concept and Gender Role Variables with Male and Female Eighth Graders' Attitudes toward Science

Variables	Attitudes toward Science (SO) Male r	Female r	z
Male dominance-ability/leadership/ach. (SPS)	.26**	.18	0.52
Higher male expectations (SPS)	.25**	.26*	0.07
Males-assertiveness/females-empathy (SPS)	.20*	.16	0.26
Males-risktaking (SPS)	.32**	.34**	0.14
Males-inquisitiveness (SPS)	.26	.26**	0.00
Males-active/females-passive (SPS)	.21*	.18	0.19
Career appropriateness-males (CAS)	.49**	.36	1.00
Career appropriateness-females (CAS)	.25**	.17	0.52
Self-as-student (SURPO)	.78**	.68**	1.35
Self-teacher perceptions (SURPO)	.62**	.53**	0.85
Self-social relations (SURPO)	.68**	.56**	1.21
Masculinity (ESRI)	.26**	-.21*	3.00**
Femininity (ESRI)	.38**	-.03	2.69**
Self concept-overall (API)	.22**	.20	0.06
Self concept in science (API)	.44**	.31**	0.95
Self concept in mathematics (API)	.56**	.24*	2.40*

*Significant at .05 level.

**Significant at .01 level.

In the eighth grade significant differences were found in the two gender groups' perceptions of personal traits as dimensioned into traditional "masculine" and "feminine" profiles as related to interests in science. Males' self perceptions of their masculine traits as measured by the ESRI were more positively correlated with their attitudes toward science. For the girls' group, a negative correlation was found between perceptions of stereotyped masculine traits and attitudes toward science. Males' self perceptions of personal traits classified traditionally as feminine, however, were more positively correlated with their attitudes toward science while females' self perceptions of their feminine traits were negatively correlated with the girls' attitudes toward science. These data appear to indicate that traits stereotyped as both masculine and feminine among boys are associated with their interests in science, while among girls both of these traits dimensions are negatively associated with attitudes toward science. Self concept in mathematics, though related to science interests in both gender groups, was also more positively correlated with attitudes toward science for males in the eighth grade than for females. No differences, however, were found for the two gender groups in the relationships of their self concept in science scores to their attitudes toward science. In both gender groups, again, self concept in science was positively correlated with attitudes toward science. Differentiation between males' and females' attitudes toward self, then, appeared to be more associated with self in mathematics than with self in science as attitudes toward science were predicted.

Changes within the female group, itself, was observed as the girls progressed from the seventh to eighth grade. Girls' perceptions

of their personal traits classified traditional as "masculine" in their eighth grade come to be negatively correlated with their interests in science, as did their "feminine" traits. Self concept for girls in reference to the school setting, and particularly associated with mathematics and science, continued to be positively correlated with science attitudes.

During the same year, the eighth grade boys showed higher correlation between their attitudes of male dominance and their attitudes toward science. Males' acceptance of more career areas in science as being appropriate for males also showed a higher correlation with the boys' attitudes toward science in the eighth grade than in the seventh grade. Measures of self concept in the school setting and in relationship to mathematics for males, correlated more positively with their attitudes in science in the eighth grade than in the seventh grade. Attitudes toward science and self concept in science correlated less (though still significantly) in the eighth grade.

In summary, as the males matured in relationship to science attitudes, they appeared to develop more positive self concepts in school and school-social relations, their self perceptions of stereotyped traits of masculinity and femininity related more positively to their attitudes toward science. The males' view of appropriate careers in science for men became more pronounced in relationship to science attitudes and their stereotyped views of male participation in science increased.

Within the female group, the relationship between acceptance of the stereotype of male participation in science and the girls' attitudes toward science become more evident. Those girls who liked

science apparently accepted the stereotyped position of male dominance in science activities. At the same time, however, they began to see more science careers as appropriate for male and females. Those girls who like science in the eighth grade also appeared to rate their personal traits on both masculinity and femininity lower at the same time. In relationship to science attitudes, self perception in school for the girls increased in the eighth grade, while their self perceptions in science and mathematics decreased.

Research Question Four

Question four explores the relationships among variables within classroom interactions, personal variables and perceptions, and the influences of significant others.

What relationships exist between male and female students' classroom interactions and learning levels expected by teachers and the following variables: concepts of self and sex role in science, race, socioeconomic status, social rating by peers and students' perceptions of parental influences upon science interests? Four separate canonical correlation models were used to investigate this relationship between self/social variables and actual classroom interactions observed. The social/self related variables were measured through use of the Survey of Pupil Opinion, the Affective Perception Inventory, the Elementary Sex-Role Inventory, the Career Appropriateness Scale, the Science Participation Scale, the Social Acceptance Scale and the Parental Influences and Career Plans Scale. A total of 26 variables were selected from this battery to represent affective measures of self, sex role, social status, demographic variables and parental influences in relationship to science. In addition, parent income level was used as a measure of socioeconomic status.

The classroom behaviors were collected by observation and by analysis of transcribed audiotapes. Classroom variables included in this analysis were source of classroom interactions, types of classroom interactions, feedback, instructional questions, correctness of student responses, student response time and teacher wait time.

Results of canonical correlations relating the self/sex role/social status/parental influences variables to the classroom behaviors

are given on Table 18. These data indicate statistically significant relationships ($p < .05$) between the variable sets for both gender groups in the seventh grade. In the eighth grade, however, while a relationship at the .05 level is indicated for males, the relationship for females was found significant only at the .10 level.

Relationship of Self/Sex Role/Social Status to Classroom Interactions for Girls

Seventh Grade. The girls while in the seventh grade exhibited perceptions of self/sex role/social status/parental influences which were related to their classroom interactions and teacher expectations as dimensioned in two canonical correlation roots. A communality of 90.25% of variance in the two sets of variables was found for the first canonical factor and a communality of 88.36% of shared variance was discovered for the second relationship shown in the analysis. As can be observed on Table 19, the first factor appeared to describe a relationship where those seventh grade females who perceived themselves as having more positive school social relations, but negative self-teacher perceptions, and having lower parental support for advanced science activities/career interest also demonstrated fewer types of classroom interactions. Sources of their interactions were teacher to student or, to a lesser degree, student to teacher. Frequences of all types of classroom interactions were lower for these students in this set. Teacher feedback consisted of more simple acknowledgment of responses or, more often, teacher restatement of questions or answers given. Girls in this behavioral set gave more incorrect responses to teachers' queries, but also responded to teachers' remarks more often, correct or incorrect. Teachers prompted, praised or criticised these

Table 18

Significance of Canonical Roots Relating Self/Sex Role Variables, Peer Social Acceptance, Parental Influences in Science, Race and Socioeconomic Status to Classroom Interactions and Expected Cognitive Learnings for Both Sex Groups and the Seventh and Eighth Grade Levels

Model	Grade	Gender	Eigenvalue	Canonical Correlation	R^2	Wilks' Lambda	df	Chi Square
1	7th	Female	.91	.95	.9025	.000	702	9999.00***
			.89	.94	.8836	.000	650	755.40***
2	7th	Male	.91	.96	.9216	.000	675	805.41***
3	8th	Female	.92	.96	.9216	.000	729	781.03*
4	8th	Male	.92	.96	.9216	.000	756	9999.00***
			.89	.94	.8836	.000	702	840.53***
			.84	.92	.8464	.000	650	727.67**

*Significant at .10 level.

**Significant at .05 level.

***Significant at .01 level.

Table 19

Correlation of Seventh Grade Girls' Self Concept, Sex-Role Perceptions, Race, Socioeconomic Status, Peer Social Status and Perceptions of Parental Influence on Science Interests with Classroom Interactions and Levels of Learning Expected by Teachers

Variables	Canonical Roots[1] I	II
Set I		
Self as student (SURPO)	.06	(.37)
Self-teacher perceptions (SURPO)	(-.33)	-.02
Self-school social relations (SURPO)	(.45)	-.12
Career appropriateness-females (CAS)	(.40)	.26
Career appropriateness-males (CAS)	-.15	(-.43)
Male dominance/ability/leadership/ achievement (SPS)	.16	-.17
Male assertiveness/female empathy (SPS)	.08	(.34)
Male risk-taking (SPS)	-.02	-.26
Male inquisitiveness (SPS)	.22	.19
Males-active/females-passive (SPS)	-.13	.10
General self concept (API)	.16	.11
Self concept in mathematics (API)	-.03	(-.31)
Self concept in science (API)	.06	.16
Masculinity (ESRI)	.08	.05
Femininity (ESRI)	-.22	-.14
Race	-.24	(.47)
Best friends (Sociogram)	.00	(.31)
Desired best friends (Sociogram)	-.07	(-.52)
Chosen to lead science project	(.40)	.27
Income	.22	-.07
Fathers' attitudes/advanced science	.21	(-.98)
Fathers' attitudes/basic science	(.30)	(.81)
Mothers' attitudes/advanced science	(-.94)	(.30)
Mothers' attitudes/basic science	(.47)	.21
Fathers' encouragement to be scientist	(-.90)	-.09
Mothers' encouragement to be scientist	(-.71)	.09
Set II		
Source of classroom interactions		
Teacher to student	(6.87)	(22.70)
Student to teacher	(2.86)	(10.27)
Student to student	(-.46)	(.66)
Types of classroom interactions		
Direct questions	(-8.16)	(-26.55)
Class business	(-1.51)	(-6.07)
Disciplinary	(-1.09)	(-1.41)
Social	(-.78)	(-2.30)

Table 19

Correlation of Seventh Grade Girls' Self Concept, Sex-Role Perceptions, Race, Socioeconomic Status, Peer Social Status and Perceptions of Parental Influence on Science Interests with Classroom Interactions and Levels of Learning Expected by Teachers (continued)

Variables	Canonical Roots I	II
Call out answers to indirect questions	(-3.40)	(-8.48)
Unsolicited responses	(-.75)	(-1.74)
Solicited responses	(-4.11)	(-14.83)
Feedback		
None	(.75)	(-1.02)
Simple acknowledgment	(.95)	(-.38)
Restate question/answer	(1.06)	(-.45)
Prompt	(-.79)	(-1.00)
Praise	(-.60)	-.04
Clarification	-.04	(-.38)
Correction	-.15	-.23
Criticism or Disciplining	(-.52)	(-.31)
Elaboration	-.17	.11
Instructional questions		
Yes	(.78)	(1.70)
No	(.39)	(.76)
No response to question	(-.68)	(.33)
Correctness of response		
Incorrect	(.86)	(.51)
Correct	(-.49)	(-.92)
Student response time	-.10	-.01
Teacher wait time	.04	.06

[1]Those variables loading .30 or more on canonical roots were considered to characterize the root function.

students less often also. These girls viewed more careers in science, as appropriate for women to pursue and were nominated by their class members as desired group leaders for planning an experiment.

The second canonical factor describing the self/sex role/social behaviors of girls as related to classroom behaviors in the seventh grade characterized behaviors for girls (predominantly black) who perceived self-as-student more positively were considered best friends by more peers, but also were less often selected by their peers as a desired new best friend. These behaviors were associated with stereotyped concepts of males being more assertive and females empathetic in science activities, as well as a view of fewer career areas being appropriate for men to enter in science. Girls with these characteristics also had lower self concepts in mathematics. They perceived mothers as supportive of advanced studies in science in high school, but they saw fathers as more supportive of basic science studies and not advanced studies for them. In observed classroom interactions, seventh grade girls who exhibited these characteristics described also tended to display fewer types of classroom interactions and to receive less teacher feedback, regardless of the type. Sources of classroom interactions, however, tended to be teacher-to-student, as well as student-to-teacher and student-to-student, with the teacher-to-student interactions loading more heavily in the canonical relationship. This analysis was the only time in which student-to-student correlations were observed to load positively for either gender or grade group. These students, however, tended also to give fewer correct responses and more "no response" or more incorrect answers.

Eighth grade. A canonical factor significant at the .10 and describing a communality of 92.16% variance between the self/sex role/

social factors and classroom interactions/expectations was identified. Canonical root loadings of this relationship are given on Table 20.

This canonical root described a relationship for eighth grade girls who perceived themselves more positively in school social relationships and had more positive general self concepts. These girls viewed males as more assertive and females more emphathetic in science, but perceived males lower in the areas of risktaking and inquisitiveness in science. They viewed their fathers as having less positive attitudes toward their taking advanced sciences in high school and they interpreted their mothers' attitudes as more positive toward their electing basic science courses. In science classes, girls with these perceptions of self/sex role/social behaviors had fewer classroom interactions, regardless of type or source. They also tended to receive less teacher feedback but were asked more questions of both the instructional and non-instructional types. They were asked more information types of questions, but they were also asked relatively more types of attitudinal questions than observed in the seventh grade. They had relatively fewer "no responses" to questions and answered relatively more questions, both correctly and incorrectly. The teachers, however, waited relatively a shorter time to respond to their comments or questions.

Summary of Observations. An examination of the canonical models for relating self/gender role/social/parental expectation behaviors for girls to their classroom activities at each of the grade levels indicates that more complex relationships existed between the classroom variables for girls in the seventh grade than in the eighth grade. Two different canonical roots were discovered at the seventh grade describ-

Table 20

Correlation of Eighth Grade Girls' Self Concept, Sex-Role Perceptions, Race, Socioeconomic Status, Peer Social Status and Perceptions of Parental Influence on Science Interests with Classroom Interactions and Levels of Learning Expected by Teachers

Variables	Canonical Root[1] I
Set I	
Self-as-student (SURPO)	-.19
Self-teacher perceptions (SURPO)	-.21
Self-social relations (SURPO)	(.72)
Career appropriateness-females (CAS)	-.02
Career appropriateness-males (CAS)	-.06
Male dominance-ability/leadership/achievement (SPS)	.20
Male assertiveness-female empathy (SPS)	(.41)
Male risk-taking (SPS)	(-.67)
Male inquisitiveness (SPS)	(-.36)
Higher male expectations (SPS)	.25
Males-active/females-passive (SPS)	.24
General self concept (API)	(.40)
Self concept in mathematics (API)	-.14
Self concept in science (API)	.14
Masculinity	-.10
Femininity	-.16
Race	-.19
Best friends (Sociogram)	.18
Desired best friends (Sociogram)	.04
Chosen to lead science project (Sociogram)	.09
Income	.13
Fathers' attitude/advanced science	(-.39)
Fathers' attitude/basic science	-.26
Mothers' attitude/advanced science	.26
Mothers' attitude/basic science	(.50)
Fathers' encouragement to be scientist	.09
Mothers' encouragement to be scientist	.07
Set II	
Source of classroom interactions	
Teacher to student	(-.78)
Student to teacher	(-1.53)
Student to student	(-.33)
Types of classroom interactions	
Direct questions	(-3.13)
Class business	(-.21)
Disciplinary	(-.77)
Call out answers to direct questions	(-1.64)
Unsolicited responses	(-1.01)
Solicited responses	(-2.66)

Table 20

Correlation of Eighth Grade Girls' Self Concept, Sex-Role Perceptions, Race, Socioeconomic Status, Peer Social Status and Perceptions of Parental Influence on Science Interests with Classroom Interactions and Levels of Learning Expected by Teachers (continued)

Variables	Canonical Root I
Feedback	
None	(-1.22)
Simple acknowledgment	(-1.54)
Restate answer/question	(-4.33)
Prompt	(-2.23)
Praise	(-.56)
Clarification	(-1.07)
Correction	(-.77)
Criticism or Disciplinary	-.15
Elaboration	-.76
Instructional questions	
Yes	(6.67)
No	(3.27)
Domain of questions	
Information	(2.79)
Attitudes	(.84)
No response to question	.17
Correctness of response	
Incorrect	(1.55)
Correct	(1.73)
Student response time	.03
Teacher wait time	(-.33)

[1]Those variables loading .30 or more on canonical roots were considered to characterize the root function.

ing, respectively, a group of girls nominated for group leadership in science who did not have strong parental support for pursuit of advanced science and a group of girls (predominantly black) who had positive views of themselves as students and who had mothers' support (but not fathers' support) to pursue advanced science. Both of these two sets of traits were negatively related to the types of classroom interactions and sources of these interactions observed, except that the group of predominantly black girls had more student-to-student classroom interactions and fewer of all types of interactions observed.

In the eighth grade, the canonical relationship correlating self/sex role/social behaviors to classroom interactions appeared to explain a more homogeneous pattern of behaviors. Canonical factors in which race differences load heavily, for example, did not even approach statistical significance. It appeared that girls who perceived themselves as having good relationships also felt that parents (particularly fathers) were less supportive of further advanced studies in science. These girls interacted less in class with the teachers and teachers waited a shorter time for their responses.

On the basic of these analyses, it was concluded that parental expectations were associated with the girls' classroom interactions; i.e., those girls whose fathers and, to a lesser degree, mothers did not expect them to study advanced science also did not participate as much in classroom interactions. Whether or not the girls had higher or lower general self concept did not appear to be related to their classroom interactions, but race loaded more heavily in a factor which described girls having more student-to-student classroom interactions. It appears important also that at both grade levels girls' perception

of boys as being more assertive was negatively related to their participation in classroom activities in science.

Relationship of Self/Sex Role/Social Status to Classroom Interactions for Boys

Seventh grade. Within the male subsample at the seventh grade level, one significant canonical correlation was identified which was associated with 92.16% of the variance in the sets of variables describing classroom interactions and self perceptions/social interactions. Variable loadings for this root are given in Table 21. At this level, classroom interactions for males who were recognized as "best friends" by the peer group, who were chosen to lead science experiments by the peer group and who perceived themselves as having more masculine traits in the traditionally stereotyped frame of reference were described. These males received relatively more teacher feedback of all types, except for criticism and elaboration. In classroom interactions, however, these males were involved in fewer teacher-to-student and student-to-teacher interactions and were asked fewer direct questions. They also called out relatively fewer answers to indirect questions and gave fewer solicited responses. This group was asked questions characterized at the basic information domain level. The correctness, or incorrectness, of these males' responses to questions correlated positively with the personal traits described. It did not appear to make much difference whether the reponses were correct or incorrect. The students received more teacher feedback also felt that more careers in science (traditional and nontraditional) were appropriate for females, but that all career areas in science were less appropriate for males. These males who were very popular with the

Table 21

Correlation of Seventh Grade Boys' Self Concept, Sex-Role Perceptions, Race, Socioeconomic Status, Peer Social Status and Perceptions of Family Influence and Levels of Learning Expected by Teachers

Variables	Canonical Root[1] I
Set I	
Self-as-student (SURPO)	.12
Self-teachers perception (SURPO)	.16
Self-social relations (SURPO)	-.10
Career appropriateness - Females (CAS)	(.69)
Career appropriateness - Males (CAS)	(-.33)
Male dominance - ability/leadership/achievement (SPS)	-.01
Male assertiveness/female empathy (SPS)	(-.56)
Male risk-taking (SPS)	.29
Male inquisitiveness (SPS)	-.05
Higher male expectations (SPS)	.20
Males-active/females-passive (SPS)	-.06
General self concept (API)	-.12
Self concept in mathematics (API)	-.02
Self concept in science (API)	.11
Masculinity (ESRI)	(.37)
Femininity (ESRI)	(-.42)
Race	-.08
Best friends (Sociogram)	(.72)
Desired best friends (Sociogram)	-.21
Chosen to lead science project (Sociogram)	(.38)
Fathers' attitudes/advanced science	.06
Mothers' attitudes/advanced science	.01
Fathers' encouragement to be scientist	-.08
Mothers' encouragement to be scientist	.03
Set II	
Source of classroom interactions	
Teacher to students	(-3.41)
Students to teacher	(-.71)
Students to students	.01
Interaction	
Direct questions	(-3.10)
Class business	.11
Disciplinary	-.22
Social	-.12
Call out answers to indirect questions	(-1.05)
Unsolicited responses	-.29
Solicited responses	(-.30)
Feedback	
None	(.43)
Simple acknowledgment	(.62)
Restate answer/question	(.89)

Table 21

Correlation of Seventh Grade Boys' Self Concept, Sex-Role Perceptions, Race, Socioeconomic Status, Peer Social Status and Perceptions of Family Influence and Levels of Learning Expected by Teachers (continued)

Variables	Canonical Root I
Prompt	(.72)
Praise	(.59)
Clarification	(1.22)
Correction	(.49)
Criticism or Disciplinary	.21
Elaboration	.01
Instructional questions	
Yes	(-.52)
No	(-.94)
Domain of questions	
Information	(1.15)
No response to question	(.47)
Correctness of response	
Incorrect	(1.80)
Correct	(2.70)
Student response time	.01
Teacher wait time	-.03

[1]Those variables loading .30 or more on canonical roots were considered to characterize the root function.

group in science classes did not see males as more assertive in science than females.

Eighth grade. The relationship between self/sex role/social/parental support variables in science activites and classroom interactions appeared to be more complex for males in the eighth grade than in the seventh grade. Whereas only one statistically significant pattern of behavior was observed for the group while in the seventh grade, three canonical roots reach statistical significance (.05 level or beyond) for the same group in the eighth grade. These data are given on Table 22.

The first canonical root describing 92.16% of the communality of variance in the two variable sets described males who scored higher on traits characterized as more feminine and more masculine in the stero-typed tradition. These males had lower perceptions of self as students and lower self concepts in mathematics. They were desired as best friends by fewer peers who perceived themselves positively in both social and teacher relations. These males with less developed "masculine" traits also felt that more careers in science were appropriate for women to enter. These students perceived their fathers' attitudes toward their taking advanced courses in science less positive and their mothers' attitudes toward taking basic science courses more positive. Students registering these perceptions and parent and peer influences had fewer classroom interactions of any type and received no teacher feedback to their responses more often. They did receive more prompting, more criticism and more elaboration on their responses from the teacher. They were asked more instructional questions and fewer non-instructional questions. They gave no responses more often and were more often

Table 22

Correlation of Eighth Grade Males' Self Concept, Sex-Role Perceptions, Race, Socioeconomic Status, Peer Social Status and Perceptions of Parental Influence on Science Interests with Classroom Interactions and Levels of Learning Expected by Teachers

Variables	Canonical Roots[1] I	II	III
Set I			
Self-as-student (SURPO)	(-1.17)	(-.76)	(-.47)
Self-teacher perceptions (SURPO)	(.53)	(.38)	.15
Self-social relations (SURPO)	(.71)	(.30)	-.08
Career appropriateness-females (CAS)	(.42)	.03	(-.39)
Career appropriateness-males (CAS)	.05	(.43)	.19
Male dominance-ability/achievement leadership (SPS)	-.18	-.16	.04
Male assertiveness-female empathy (SPS)	.03	.23	-.23
Male risk-taking (SPS)	-.17	.17	(.87)
Male inquisitiveness (SPS)	.11	-.18	(-.56)
Higher male expectations (SPS)	-.02	(-.57)	(-.40)
Males-active/females-passive (SPS)	(.43)	-.05	-.18
General self concept (API)	.03	-.01	-.15
Self concept in mathematics (API)	(-.30)	-.13	-.17
Self concept in science (API)	.05	-.02	-.13
Masculinity (ESRI)	(-.40)	.22	(.94)
Femininity (ESRI)	(.30)	(-.33)	-.01
Race	.07	.05	.18
Best friends (Sociogram)	.24	.02	.05
Desired best friends (Sociogram)	(-.51)	-.10	-.05
Chosen to lead science project (Sociogram)	.21	-.18	.02
Socioeconomic status (Economic)	.10	(.32)	(.42)
Fathers' attitudes/advanced science	(-4.34)	(6.70)	(-.62)
Fathers' attitudes/basic science	.14	(-.44)	-.27
Mothers' attitudes/advanced science	.11	.11	(.91)
Mothers' attitudes/basic science	(4.20)	.11	.27
Fathers' encouragement to be scientist	.02	(.30)	.06
Mothers' encouragement to be scientist	.16	-.27	-.04
Set II			
Source of classroom interactions			
Teacher to student	(-20.46)	(-1.45)	(23.41)
Student to teacher	(-12.20)	(-.91)	(13.55)
Student to student	(-.49)	.06	(.46)
Types of classroom interactions			
Direct questions	(-12.70)	(9.82)	(20.65)
Class business	(-4.47)	(2.89)	(5.42)
Disciplinary	(-.77)	(.61)	(1.26)
Social	(-.40)	(.76)	(1.16)

Table 22

Correlation of Eighth Grade Males' Self Concept, Sex-Role Perceptions, Race, Socioeconomic Status, Peer Social Status and Perceptions of Parental Influence on Science Interests with Classroom Interactions and Levels of Learning Expected by Teachers (continued)

Variables	Canonical Roots I	II	III
Call out answers to indirect questions	(-9.98)	(7.93)	(16.44)
Unsolicited responses	(-6.89)	(4.17)	(9.94)
Solicited responses	(-7.42)	(4.96)	(10.84)
Feedback			
None	(.94)	(.70)	(-2.84)
Simple acknowledgment	.18	(.55)	(-2.17)
Restate answer/question	.19	(1.10)	(-3.25)
Prompt	(.58)	(1.26)	(-2.09)
Praise	.11	(.32)	-.11
Clarification	.23	(.53)	(-.94)
Correction	-.10	.29	-.21
Criticism or Disciplining	(.75)	.18	(-1.15)
Elaboration	(.63)	-.10	(-.80)
Instructional question			
Yes	(.39)	(-1.46)	(-6.15)
No	(-1.96)	(-3.22)	(-12.17)
Domain of questions			
Information	(-.68)	(-3.74)	(-8.87)
No response to question	(-.95)	(.33)	(.80)
Correctness of response			
Incorrect	(36.77)	(-9.54)	(-28.34)
Correct	(28.87)	(-5.98)	(-19.68)
Partially correct	(7.51)	(-1.61)	(-5.08)
Student response time	.08	.26	.24
Teacher wait time	.18	-.24	-.14

[1]Those variables loading .30 or more on canonical roots were considered to characterize the root function.

incorrect than correct in their answers.

The second canonical factor described the classroom interactions and expectations of male students in the eighth grade who also had lower concepts of themselves as students and higher concepts of self in teacher and social relations. Males contributing to this factor, however, rated themselves lower on traits traditionally described as feminine. These males selected more career areas as appropriate for men to enter and also did not feel so strongly that males, in comparison to females, are expected to achieve more in science. These males came from higher income level homes and perceived their fathers as more supportive of their participation in advanced, rather than in basic, science courses in high school. These males also recognized their fathers' encouragement to be a scientist more positively.

The source of interactions in the classroom appeared negatively related to the characteristics of males described in this second root, but these students received more teacher feedback in all areas except correction, criticism and elaboration. Their classroom interactions, regardless of type, were positively associated with their perceived personal/sex role/social traits. These boys with more positive encouragement from fathers and higher income backgrounds tended to receive fewer questions either correctly or incorrectly. They also had more "no responses" to questions.

The third canonical factor describing 84.64% of the variance common to Set I and Set II of the variables in this analysis describes a trait set for males who rated themselves more masculine on the Elementary Sex-Role Inventory. These males viewed boys as being more risk-taking than girls in science activities but not as being more

inquisitive or as having higher expectations in science. These males also had lower concepts of self as a student and came from families with higher income levels. Males whose traits were characterized in this factor saw fathers as less supportive and mothers as more supportive of their taking classes in advanced science. Males having the above characteristics displayed more sources and types of classroom interactions. However, they received relatively less teacher feedback of any type. They gave more "no responses" and the degree of correctness of responses, whether total incorrect, correct or partially correct, was negatively related to their personal traits.

Summary of observations. In reverse to the pattern noted for females, the interactions between males' classroom behaviors and their self perceptions, sex roles, social acceptance and family support for science activities appeared more evident in the eighth grade than in the seventh grade. The derivation of three canonical roots describing different interaction patterns of these traits demonstrates this phenomenon very vividly.

The set of traits described for males in the seventh grade appeared to be supported by teacher feedback. When the set of personal variables varied in the three factors derived in the eighth grade, patterns of teacher responses changed. Those children from relatively higher income families, for example, participated in more classroom interactions, regardless of their other traits. For those boys whose parents were perceived as supportive of their further study of science, a pattern of supportive teacher feedback was observed. For those males whose fathers were not supportive of advanced studies in science, teacher feedback was negatively correlated; i.e., those

males who viewed their fathers as non-supportive of advanced studies in science also received less teacher feedback.

These relationships also appear to demonstrate the significance of traits traditionally classified as masculine and feminine as they interact with parent expectations and students' self perceptions in predicting students' classroom behaviors.

Research Question Five

Question five explores the relationship between science attitudes and cognitive variables.

What relationships, if any, exist between male and female students' achievement in science as measured by a standardized test and by grades earned in science; measures of academic aptitude; and their attitudes toward science? Four separate multiple regression models were used to study the relationship of achievement and aptitude variables to males' and females' attitudes toward science as assessed in the seventh and eigth grades, respectively, through administering the Science Opinionnaire.

Table 23 indicates that three measures, spatial relations (DCAT) grades earned in science at the sixth grade level and science achievement as measured by a standardized test (CST) contributed significantly to the variance observed in seventh grade females' attitudes toward science. These variables, collectively, explained 9.75% of the total variance measured by the SO. Spatial abilities as determined by the Developing Cognitive Abilities Test served as the best predictor of attitudes toward science for girls, but the correlation was negative, i.e., those with lower spatial abilities had more positive attitudes.

At the eighth grade level, spatial abilities also served as a significant predictor of females' attitudes toward science as assessed by the same instrument. The directionality, however, of the relationship had reversed. Those girls' with higher scores in spatial abilities also expressed more positive attitudes toward science. Another variable, verbal aptitude (DCAT) also explained a significant amount

of the variance in the attitudinal scores. Spatial abilities and verbal aptitude, together, explained 10.05% of the total variance in attitudes toward science.

For the male group in the seventh grade, two variables, science achievement as assessed by the Cooperative Science Test and grades in science earned during the seventh grade were the two variables which contributed significantly to the variance observed in the boys' attitudes toward science. These two variables, collectively, explained only 4.69% of the total variance in attitudes. These data are given on Table 24. The grades which males made in science served as the only significant predictor of attitudes toward science for the males during the eighth grade. This variable was associated with only 9.2% of the variance in science attitudes.

These analyses relating achievement and aptitude variables to the male and female groups' attitudes toward science yielded lower correlations than were expected. In comparing the relationships for the male and female groups, one difference worthy of note appeared to be the association between spatial abilities and attitudes toward science among the female group. Initially, in the study, a negative relationship was observed and then later in the eighth grade, the relationship was indicated as positive. No obvious explanation is available for this shift in relationships between spatial abilities and science attitudes for the girls at this level of their maturity. It was discovered, however, that females gained significantly in spatial relations between the seventh and eighth grades (see Appendix A).

Also, it was observed that quantitative aptitude correlated significantly with males' attitudes toward science at the eighth grade, while it has almost no correlation with females' attitudes toward science.

Table 23

Predicting Females' Attitudes Toward Science

Grade	Predictors	R	R^2	Simple r	F
7	Spatial Abilities (DCAT)	.2064	.0426	-.23*	4.25**
	Teacher Assigned Grades (6th)	.2932	.0864	.18	3.45**
	Science Achievement (CST)	.3122	.0975	.14	2.37*
	Overall Academic Aptitude (DCAT)	.3205	.1027	-.05	0.87
	Teacher Assigned Grades (7th)	.3224	.1040	.06	0.41
	Quantitative Aptitude (DCAT)	.3227	.1441	-.62	0.10
	Verbal Aptitude (DCAT)	.3266	.1067	.02	0.19
8	Spatial Abilities (DCAT)	.1492	.0223	.15	6.87**
	Verbal Aptitude (DCAT)	.3169	.1005	.12	6.26**
	Teacher Assigned Grades (7th)	.3459	.1196	-.13	1.55
	Overall Academic Aptitude (DCAT)	.3486	.1215	-.03	0.04
	Science Achievement (CST)	.3490	.1218	-.03	0.02
	Quantitative Aptitude (DCAT)	.3490	.1219	-.03	0.01

*Significant at .05 level.

**Significant at .01 level.

Table 24

Predicting Males' Attitudes Toward Science

Grade	Predictors	R	R^2	Simple r	F
7	Science Achievement (CST)	.1823	.0332	.18	2.68**
	Teacher Assigned Grades (7th)	.2166	.0469	.11	2.52**
	Teacher Assigned Grades (6th)	.2623	.0689	.13	2.09
	Spatial Abilities (DCAT)	.2735	.0748	.02	0.49
	Quantitative Aptitude (DCAT)	.2809	.0789	.11	0.32
	Overall Aptitude (DCAT)	.2848	.0811	.08	0.18
	Verbal Aptitude (DCAT)	.2951	.0870	.08	0.47
8	Teacher Assigned Grades (8th)	.3032	.0920	.30*	6.26**
	Spatial Abilities (DCAT)	.3155	.0995	.10	1.03
	Quantitative Aptitude (DCAT)	.3471	.1205	.23*	1.83
	Verbal Aptitude (DCAT)	.3548	.1259	.13	0.58
	Teacher Assigned Grades (6th)	.3623	.1313	.19	0.52
	Science Achievement (CST)	.3641	.1326	.11	0.11

*Significant at .05 level.

**Significant at .01 level.

Research Question Six

Question six examines gender differences relative to learning outcomes and science attitudes.

What overall differences in learning outcomes in science are observed between male and female students relative to aptitude, achievement measured by a standardized test, grades earned in science, an attitude toward science scale, and aptitude for learning? Separate discriminant analyses were computed for differentiating between the two gender groups on the variables of attitudes toward science, achievement on a standardized test, grades earned in science, verbal aptitude, quantitative aptitude and spatial relations abilities. Results of these analyses are given on Table 25. As can be seen from these data, significant differences were observed in the performance of the males and females at each of the grade levels when the attitude, aptitude and achievement variables were considered as a composite set of discriminant variables.

On Table 26, it can be observed that the two gender groups in the seventh grade did not differ significantly on each of the criterion variables when they were considered separately in univariate analyses. None of the univariate F ratios reached 3.83, the value necessary for significance at the .05 level. In the multivariate analyses, however, a set of six variables was found to discriminate between the performance of males and females at the .05 level of significance. At the seventh grade level, then, it was concluded that males differed from females in their overall performance when a composite set of aptitude, attitude and achievement variables were considered. Females had more

Table 25

Overall Differences in Attitudes, Aptitudes and Achievement of Males and Females in Science

Grade	Eigenvalue	Canonical R	Wilks' Lambda	df	Chi Square
7th	.09	.29	.91	6	13.35*
8th	.08	.28	.92	3	12.10**

* Significant at .05 level

** Significant at the .01 level

Table 26

Variables of Aptitude, Achievement and Attitudes in Science Discriminating between Males and Females at the Seventh Grade Level

Variables	Male $\bar{X}$	Female $\bar{X}$	Univariate F	Correlation with Function[1]
Cooperative Science Achievement (CST)	23.68	21.08	1.83	(.33)
Grades Earned in Science (6th Grade, Overall)	80.64	79.93	.12	.08
Grades Earned in Science (7th Grade, (1st semester)	86.16	80.63	1.89	(.33)
Verbal Aptitude (DCAT)	15.75	14.89	.53	(.18)
Quantitative Aptitude (DCAT)	9.11	9.63	.38	(.14)
Spatial Relations (DCAT)	5.81	6.41	.87	(.21)
Attitudes toward Science (SO)	70.51	73.23	2.70	(.40)

[1]Variables enclosed in parentheses indicate inclusion in discriminant function.

postive attitudes toward science and displayed more aptitude in spatial relations and quantitative areas than did the males. The males, on the other hand, scored higher on the standardized achievement test in science, made better grades in science during the sixth grade, and displayed more verbal aptitide than did the girls.

At the eighth grade level, as illustrated in Table 27, none of the variables showed significant differences in the gender groups' performance on the univariate analyses. In the multivariate comparison, however, a set of three variables, attitudes toward science, achievement as measured by a standardized test and grades earned in science during the eighth grade, was found to discriminate significantly between the boys and girls. In this multivariate analysis, the females were found to score lower on the Cooperative Science Test. They earned higher grades in science during the seventh grade, and these girls expressed more positive attitudes toward science than did the boys in the eighth grade. During both measurement periods, the girls were found to express more positive attitudes toward science than did the boys, but to score lower on the standardized test in science. As seventh graders, the boys earned higher grades up to the time of the data collection of mid-year grades, but the girls earned higher grades when the grades for the complete seventh grade were compared. The achievement of the girls, as indicated by grades earned in science class, appeared to improve during the period of the study.

It was concluded that the male and female groups really did not differ significantly on any of the measures of attitude, aptitude and achievement when they were considered as single criterion variables during each of the separate years. When the variables were considered

Table 27

Variables of Aptitude, Achievement and Attitude in Science Discriminating between Males and Females at the Eighth Grade Level

Variables	Male $\bar{X}$	Female $\bar{X}$	Univariate F	Correlation with Function[1]
Cooperative Science Achievement (CST)	24.93	20.99	3.84	(.54)
Grades in Science (7th, Overall)	79.85	81.28	2.56	(.45)
Grades in Science (8th, 1st semester)	80.67	81.33	1.47	.04
Quantitative Aptitude (DCAT)	11.33	11.96	.45	.02
Verbal Aptitude (DCAT)	16.71	17.34	.28	.06
Spatial Relations (DCAT)	7.01	6.92	.04	.11
Attitudes toward Science (SO)	61.56	64.24	1.25	(.37)

[1]Variables enclosed in parentheses indicate inclusion in discriminant function.

as composite measures, however, the groups were found to be different. The males initially scored higher on standardized tests in science and continued to do so the next year. Females scored higher on a measure of positive attitudes toward science during both years of the study. In the initial phase of the study, males earned higher grades in science, but as the students continued their studies, the females came to earn higher grades. Any slight differences in aptitude observed for the two groups in the seventh grade has disappeared by the eighth grade.

Research Question Seven

The following research question relates self concept/gender role to attitudes and achievement in science.

What relationships, if any, do male and female students' self concept and gender-role perceptions have toward their attitudes and achievement in science?

To investigate this question, four canonical correlation analyses were conducted relating 16 measures of self concept and sex-role perceptions to four measures of achievement and attitudes toward science for each of the gender groups as seventh graders and as eighth graders, respectively. Variables of self concept and sex-role perceptions studies were assessed through use of the Science Participation Scale, the Career Appropriateness Scale, the Survey of Pupil Opinion, the Affective Perception Inventory, and the Elementary Sex-Role Inventory. Measures of achievement were the total achievement score of the Cooperative Science Test and grades earned in science. Attitudes toward science were measure by the Science Opinionnarie.

Relationships for Girls

At the seventh grade level, one statistically significant canonical root (.01 level) was found relating the measures of self perceptions to attitudes and achievement in science for girls. These data are given on Table 28. When the nature of this relationship was examined carefully, it was found that the root primarily was dimensioning an attitudinal factor. In interpreting the root, as illustrated on Table 29, only those variables loading .30 or more on the canonical root were considered to be characteristic contributors to the root's

Table 28

Relationship of Female Seventh Graders' Self Concept and Gender Role Perceptions to Their Attitudes and Achievement in Science

Canonical Roots	Eigenvalue	Canonical R	Wilks' Lambda	Chi Square	df	Significance
1	.6291	.7932	.20	102.56	64	.002*
2	.2536	.5036	.34	39.58	45	.700
3	.2017	.4491	.72	21.01	28	.825
4	.1002	.3165	.90	6.70	13	.417

*Significant at .05 level.

Table 29

Variables of Self Concept and Gender-Role Perceptions Correlating Significantly with Seventh Grade Females' Attitudes and Achievement in Science

Variables	Canonical Coefficients[1]
Set I	
Self-as Student (SURPO)	(.4542)
Self-Teacher Perceptions (SURPO)	.0368
Self-Social Relations (SURPO)	.0454
Self Concept-General (API)	.1726
Self Concept in Mathematics (API)	-.0823
Self Concept in Science (API)	.0908
Male Dominance-Ability/Leadership/Achievement (SPS)	.1238
Higher Male Expectations (SPS)	(-.3801)
Males-Assertiveness/Females-Empathy (SPS)	-.1463
Males-Risktaking (SPS)	.0841
Males-Inquisitiveness (SPS)	-.2817
Males-Active/Females-Passive (SPS)	.2181
Masculinity Scale (ESRI)	.1489
Femininity Scale (ESRI)	.2130
Career Appropriateness-Males (CAS)	(-.3717)
Career Appropriateness-Females (CAS)	.1728
Set II	
Attitudes toward Science (SO)	(.8457)
Grades Earned in Science (6th Grade)	.2593
Grades Earned in Science (7th Grade)	.1623
Achievement in Science (CST)	.1021

[1]Variables enclosed in parentheses, loading on .30 or more, were considered to characterize the function.

function. It appeared that those girls who had more positive attitudes toward science also saw fewer careers in science as appropriate for males and also had less bias in their attitudes of dominant expectations for males in science. None of the achievement measures loaded enough on this factor to be considered in the analysis.

When the relationship of self and sex-role perceptions in science were studied for the female group at the eighth grade level, a significant canonical root (.001 level) describing a correlation between the two sets of variables was also discovered. The nature of this relationship, however, was somewhat different from that observed for the same girls in the seventh grade (see Table 30).

In the eighth grade, the significant relationship appeared to be describing personal traits of girls who scored higher on a standardized test in science, yet earned lower teacher-assigned grades that year and also expressed less positive attitudes toward science. Girls who exhibited these behaviors toward science expressed lower preceptions of self as a student and evaluated their self-social relations in the school lower. These girls also rated themselves higher on personal traits traditionally described as "masculine" and did not see males as more assertive and females as more passive in science activities. Though the loading of the self concept in science variable was lower than the criterion of .30 usually accepted for characterizing canonical roots (Cooley and Lohnes, 1971), this variable also related negatively (-.23) to the canonical function describing students who scored higher on a standardized test but earned lower grades and expressed more negative attitudes toward science (see Table 31).

Table 30

Relationship of Female Eighth Graders' Self Concept and Gender-Role Perceptions to Their Attitudes and Achievement in Science

Canonical Roots	Eigenvalue	Canonical R	Wilks' Lambda	Chi Square	df	Significance
1	.5825	.7632	.30	81.90	24	.000*
2	.2107	.4591	.72	22.07	15	.106
3	.0641	.2532	.91	5.86	8	.663
4	.0191	.1383	.98	1.32	3	.724

*Significant at .05 level.

Table 31

Variables of Self Concept and Gender-Role Perceptions Correlating Significantly with Eighth Grade Females' Attitudes and Achievement in Science

Variables	Canonical Coefficients[1]
Set I	
Self-as Student (SURPO)	(-.5691)
Self-Teacher Perceptions (SURPO)	.0108
Self-Social Relations (SURPO)	(-.3193)
Self Concept-General (API)	.2705
Self Concept in Mathematics (API)	-.1932
Self Concept in Science (API)	-.2315
Male Dominance-Ability/Leadership/Achievement (SPS)	.1524
Higher Male Expectations (SPS)	.1591
Males-Assertiveness/Females-Empathy (SPS)	(-.3575)
Males-Risktaking (SPS)	-.0611
Males-Inquisitiveness (SPS)	.0755
Males-Active/Females-Passive (SPS)	.0739
Masculinity Scale (ESRI)	(.2961)
Femininity Scale (ESRI)	-.0148
Career Appropriateness-Males (ESRI)	.0602
Career Appropriateness-Females (ESRI)	-.1174
Set II	
Attitudes toward Science (SO)	(-.9457)
Grades Earned in Science (7th Grade)	.0143
Grades Earned in Science (8th Grade)	(-.3546)
Achievement in Science (CST)	(.3759)

[1]Variables enclosed in parentheses, loading .30 or more, considered to characterize the function.

It appears, then, that the dominant roots describing relationships between the two sets of variables for girls for the two respective years involved a shift from more positive attitudes toward self in school toward less positive views of self in this dimension as the girls matured. Girls with personal traits stereotypically classified as "masculine" also appeared to be the ones whose attitudes and grades in science became relatively lower. Though these girls achieved relatively high on an external standardized measure, their interest and grades in science were lower.

Relationship for Boys

The relationship of self and sex-role perceptions among the male group to their achievement and attitudes in science indicated a somewhat different pattern of interactions at both the seventh and eighth grade levels. Two significant canonical roots were isolated in the male group from data collected from them in both the seventh grade and the eighth grade, respectively (see Tables 32 and 34).

The strongest canonical root, associated with a communality of nearly 64% of variances in the two sets of variables, described the personal/sex-role perceptions of males in the seventh grade who had positive attitudes toward science and scored relatively high on the Cooperative Science Achievement Test. These males had strong self concepts in science, had stronger views of males having more inquisitiveness than females in science activities, but had lower perceptions of males being more assertive and females more empathetic in science activities (see Table 33).

As given in Table 33 , in the seventh grade data set, males who had more positive attitudes toward science and yet made relatively

Table 32

Relationship of Male Seventh Graders' Self Concept and Perceptions of Gender Role to Attitudes and Achievement in Science

Canonical Root	Eigenvalue	Canonical R	Wilks' Lambda	Chi Square	df	Significance
1	.6321	.7951	.14	132.74	64	.000*
2	.3936	.6274	.39	64.24	45	.031*
3	.2494	.4994	.65	29.98	28	.364
4	.1400	.3741	.86	10.33	13	.667

*Significant at .05 level.

Table 33

Variables of Self Concept and Gender-Role Perceptions Correlating Significantly with Seventh Grade Males' Attitudes and Achievement in Science

Variables	Canonical Coefficients[1] Root 1	Root 2
Set I		
Self-as-Student (SURPO)	.2410	(.3529)
Self-Teacher Perceptions (SURPO)	.1608	.0812
Self-Social Relations (SURPO)	.1529	-.1491
Self Concept-General (API)	-.0465	(-.4710)
Self Concept in Mathematics (API)	-.0336	.0167
Self Concept in Science (API)	(.5104)	.1060
Male Dominance-Ability/Leadership/Ach. (SPS)	.0241	-.1200
Higher Male Expectations (SPS)	-.0482	(-.3944)
Males-Assertiveness/Females-Empathy (SPS)	(-.3055)	.2828
Males-Risktaking (SPS)	.1058	(.6271)
Males-Inquisitiveness (SPS)	(.4085)	-.2595
Males-Active/Females-Passive (SPS)	.1178	.2006
Masculinity Scale (ESRI)	.0195	(-.5871)
Femininity Scale (ESRI)	.0696	(.5655)
Career Appropriateness-Males (ESRI)	.0678	.1083
Career Appropriateness-Females (ESRI)	-.0475	-.0289
Set II		
Attitudes toward Science (SO)	(.9143)	(.4515)
Grades Earned in Science (6th Grade)	-.0894	-.1327
Grades Earned in Science (7th Grade)	-.0319	-.0177
Achievement in Science (CST)	(.3049)	(-.9293)

[1]Those variables loading .30 or more on canonical roots were considered to characterize the root function.

lower scores on the standardized achievement test were also those who had more positive perceptions of self-as-a-student had stronger perceptions of males being more inquisitive than females in science, had more personal traits stereotypically classified as "feminine," had fewer personal traits stereotypically classified as "masculine," had lower self concepts in general and had stronger perceptions of males being more risk-taking in science than females.

In the eighth grade as indicated on Table 35, those males who had positive attitudes toward science were those with higher concepts of self as a student. This relationship appeared to express one of general overall positive self regard and was depicted in the first canonical function.

The second canonical root at the eighth grade level was one describing males who had less positive attitudes toward science and who also scored relatively higher on the Cooperative Science Test. This pattern of behaviors was characterized by males who perceived themselves less positively in the effective student role (Self-as-Student) but view self in social relations role in school as more positive. They also had low self concept in relationship to mathematics and rated themselves higher on personal traits traditionally labelled as masculine. These males who had more negative attitudes toward science but achieved higher on the standardized test in science also viewed more careers in science as being appropriate for girls to enter.

Comparison of Gender Relationships

One year of maturation among the girls indicated a shift in the

Table 34

Relationship of Male Eighth Graders' Self Concept and Perceptions of Gender Role to Attitudes and Achievement in Science

Canonical Roots	Eigenvalues	Canonical R	Wilks' Lambda	Chi Square	df	Significance
1	.7571	.8701	.08	168.90	64	.000*
2	.4397	.6631	.35	71.96	45	.007*
3	.2614	.3113	.62	32.28	28	.263
4	.1548	.3935	.85	11.52	13	.567

*Significant at .05 level.

Table 35

Variables of Self Concept and Gender-Role Perceptions Correlating Significantly with Eighth Grade Males' Attitudes and Achievement in Science

Variables	Canonical Coefficients[1] Root 1	Root 2
Set I		
Self-as-Student (SURPO)	(.3904)	(-.6802)
Self-Teacher Perceptions (SURPO)	.0893	.0136
Self-Social Relations (SURPO)	.2762	(.4082)
Self Concept-General (API)	-.1113	.2908
Self Concept in Mathematics (API)	.1334	(-.3146)
Self Concept in Science (API)	.1531	.2095
Male Dominance-Ability/Leadership/Ach. (SPS)	.1659	-.1436
Higher Male Expectations (SPS)	.0560	-.0700
Males-Assertiveness/Females-Empathy (SPS)	.2295	-.1204
Males-Risktaking (SPS)	.2387	-.2709
Males-Inquisitiveness (SPS)	.0009	.2863
Males-Active/Females-Passive (SPS)	.0988	.0130
Masculinity Scale (ESRI)	.2131	(.4600)
Femininity Scale (ESRI)	.1058	-.0095
Career Appropriateness-Males (ESRI)	.2013	-.0413
Career Appropriateness-Females (ESRI)	.1071	(.3832)
Set II		
Attitudes toward Science (SO)	(.8701)	(-.3620)
Grades Earned in Science (7th Grade)	-.0452	.0227
Grades Earned in Science (8th Grade)	.2466	.0306
Achievement in Science (CST)	.1388	(.9480)

[1]Those variables loading .30 or more on canonical roots were considered to characterize the root function.

relationship of self concept/sex-role variables from a positive loading with attitudes toward science and grades earned to a negative loading of these variables with attitudes toward science. In addition, the combination of self assessment variables came to be more positively related to achievement for girls between the two testing periods. This shift toward less positive attitudes toward science was concurrent with the development of more negative perceptions of self as a student (SURPO) and social-self relations (SURPO), as well as a development of higher expectations for males than females in science. The females during this period, however, developed a less positive perception of male assertiveness and female empathy in science during this same period. This shift in perceptions was also related to their lowered attitudes toward science in the eighth grade. A shift was also observed in the loading of personal traits from more to less "feminine" and from less to more "masculine" for girls who scored higher on a standardized test in science but who made lower grades in science class and who also expressed more negative attitudes toward science.

Among the male group, those subjects, who at the eighth grade expressed more negative attitudes toward science and scored higher on the achievement test, also exhibited lower concepts of self as students. Similar to the female group, those males who scored higher on stereotyped traits of masculinity also had less positive attitudes toward science and made higher scores on the achievement test. Lower self concepts in mathematics also interacted more for males in this pattern of cognitive and affective responses to science as the males matured from the seventh to the eighth grade. The females did not show this negative interaction with self in mathematics and attitudes

toward science to the same extent as did the males.

An interaction of sex-stereotyped attitudes toward participation of boys and girls in science activities (male dominant) was also observed in relationship to subjects' lower attitudes and higher achievement test scores in science for both gender groups. The two factors of the Science Participation Scale entering the canonical relationship with the attitudes and achievement variable set were higher expectations for males in science and male-assertiveness/female empathy roles in science activities. Attitudes of male assertiveness in science were found to correlate negatively (.05 level) with achievement in science for both gender groups in the seventh grade and to have no significant correlation with achievement for both groups in the eighth grade. As indicated earilier in this manuscript, females developed more negative attitudes toward science and stronger views of higher expectations for males (than females) in science as they matured. The more negative loading with attitudinal and achievement variables in the eighth grade for girls, then, appeared to be associated with their growing perception of higher expectation for males in science.

In summary, it was observed than a significant shift in patterns of behavior related to science attitudes and achievement developed for both males and females between the seventh and eighth grades. The male group demonstrated a strong behavioral pattern in seventh grade for those who scored higher on the Cooperative Science Test and also expressed more positive attitudes toward science. These behaviors were associated with individuals who had positive concepts of self in science and who viewed males as more inquisitive and not more assertive

than females in science activities. In the seventh grade, in relation to sex-role perceptions, reactions to science among the females were more characterized by positive attitudes toward science and less characterized by achievement.

Both gender groups exhibited a profile of more negative attitudes toward science and higher achievement on a standardized science test in the eighth grade. This profile appeared to be related to students' perceptions of self in school and to a lesser degree for girls, toward self concept in science. The boys, however, who developed this pattern of responses to science also had lower self concepts in mathematics. Sex-role variables, particularly students' self assessment of personal traits traditionally classified as masculine and feminine, as well as their perceptions of higher expectations for males in science and male assertiveness (female empathy) in science activities, were also associated with students' cognitive and affective progress in science.

Only the male group demonstrated a pattern of self perceptual traits significantly associated in a positive relationship to attitudes toward science at the eighth grade level. Those males exhibiting positive attitudes toward science in the eighth grade were those with positive perceptions of self-as-students. Variables related to sex role and self concept in science were not correlated with positive attitudes toward science in association with achievement for males at this level.

Research Question Eight

The question attempts to determine what variables discriminate between the genders for each year.

What set of all variables studied relative to attitudes of significant others, influences in the classroom, student achievement and attitudes, discriminates significantly between male and female students in science classes?

In order to answer this question, factor analysis results were obtained from a principal axis solution using an oblique rotation of the final factor loadings. An image analysis solution, originally envisioned for the computations, could not be obtained without dropping many of the variables from consideration, due to singularity of the correlation matrix.

A dual criterion was used for choosing the number of factors to extract: (a) The factor should account for at least 2% of the total variance in an unrestricted (number of factors = number of variables) solution; and (b) The eigenvalue for the factor should be $\geq$ 1.0.

For each year's data, a twelve-factor solution was obtained. The criterion used for determining whether a variable should be considered part of a given factor was an absolute value for factor loading $\geq$ .30. Variables meeting this criterion for more than one factor were included in each appropriate factor, because the oblique rotation results in factors which are intercorrelated.

Factor scores, calculated for each student from the factor analysis mentioned above, were used as variables in a set of three discriminant analysis runs -- one using gender as group membership criterion, the second using race and the third using both gender and race.

Seventh Grade

The twelve factors obtained from the factor analysis of the seventh grade data may be summarized as follows (see Table 36):

1. Parental influence at home and school relative to science interests and pursuits
2. Influence of family factors and level of achievement
3. Students' perceptions of parents' influence on traditional/nontraditional pursuits in science
4. Attitudes toward self in school (particularly in science and math)
5. School performance
6. Bias toward girls participating in science
7. Perceptions of career appropriateness for the genders
8. Emerging gender-role identities
9. Social influence of peers in science
10. Influence of significant others on plans to pursue science
11. Achievement and aptitude
12. Traditionally feminine sources of influence on science.

The influence of parents on traditional/nontraditional pursuits associated with science are reflected strongly in factors 1 and 3, which together account for nineteen percent of the variance. Most of the variables loading on these factors are associated with the PICP-Q which measures students' perceptions of their parents' encouragement to pursue careers, coursework, and activities, associated with science. Factor 2 relates family size, income, and achievement. Factor 4, which accounted for six percent of the variance, supported the relationship

Table 36

Summary of Factor Analysis Results for Seventh Graders

Factor	Variables Loading at .30 or Greater	Direction (if negative)	Percent of Total Variance	Cumulative Variance
1. Parental Influence at home and school relative to science interests and pursuits.	Plans to take science (PICP-Q) Interest in science (PICP-Q) Father's and mothers' expectations to work at a career (PICP-Q) Father and mother's encouragement to become scientist (PICP-Q) Father's encouragement to pursue traditional and nontraditional science careers (PICP-Q) Father's encouragement to pursue traditional and nontraditional non-science careers (PICP-Q) Mother's encouragement to pursue nontraditional science careers (PICP-Q) Mother's encouragement to pursue traditional and nontraditional non-science careers (PICP-Q) Father's encouragement to pursue basic science and math courses (PICP-Q) Mother's encouragement to pursue basic science and math courses (PICP-Q) Father's encouragement of activities traditional and nontraditional for girls (PICP-Q) Mother's encouragement of activities traditional and nontraditional for girls (PICP-Q)		12.2	12.2

Table 36

Summary of Factor Analysis Results for Seventh Graders
(continued)

Factor		Direction (if negative)	Percent of Total Variance	Cumulative Variance
2. Influence of family factors and level of achievement	Age		9.5	21.7
	Number of brothers and sisters			
	California Achievement Test Battery (Reading, Math, Language Arts, SFTAA)	-		
	Socioeconomic status (income)			
	Previous year's grades in language arts, math, science	-		
	Influence of brothers in pursuing science (SOI)			
	Masculinity	-		
3. Students' perceptions of parents' influence on traditional/non-traditonal pursuits in science	Male dominance in leadership/ability/ achievement (SPS)	-	6.8	28.5
	Father's encouragement in pursuing traditional science careers (PICP-Q)	-		
	Mother's encouragement in pursuing traditional science careers (PICP-Q)	-		
	Mother's encouragement in pursuing nontraditional science careers (PICP-Q)			
	Father's encouragement to take advanced science and math courses (PICP-Q)	-		
	Father's encouragement to take basic science and math courses (PICP-Q)			
	Mother's encouragement to take advanced science and math courses (PICP-Q)	-		

Table 36

Summary of Factor Analysis Results for Seventh Graders
(continued)

Factor	Variables Loading at .30 or Greater	Direction (if negative)	Percent of Total Variance	Cumulative Variance
	Mother's encouragement to take basic science and math courses (PICP-Q)			
	Father's encouragement of traditional activities for girls (PICP-Q)	-		
	Mother's encouragement of traditional activities for girls (PICP-Q)	-		
	Mother's encouragement of nontraditional activities for girls (PICP-Q)			
	Masculinity (ESRI)			
4. Attitudes toward self in school (particularly science and math)	Self concept in school (SURPO)		6.0	34.6
	Self-as-student (SURPO)			
	Perception of teacher (SURPO)			
	Social perceptions (SURPO)			
	Science attitudes (SO)			
	Self concept-Overall (API)			
	Self concept in math (API)			
	Self concept in science (API)			
	Interest in math courses (PICP-Q)			
5. School performance	Previous year's grades in language arts, math, science	-	5.2	39.8
	Previous year's grades in social studies			
	All grades in current year			

Table 36

Summary of Factor Analysis Results for Seventh Graders
(continued)

Factor	Variables Loading at .30 or Greater	Direction (if negative)	Percent of Total Variance	Cumulative Variance
6. Bias towards girls participating in science	Bias towards girls participating in science (SPS) Male dominance (SPS) Male assertiveness (SPS) Male risktaking (SPS) Male inquisitiveness (SPS) Male expectations (SPS) Males-active/females-passive (SPS)		4.3	44.1
7. Perceptions of career appropriateness for the genders	Career appropriateness for girls (CAS) Appropriateness of careers traditional for girls (CAS) Appropriateness of careers non-traditonal for girls (CAS) Career appropriatensss for boys (CAS) Appropriateness of careers traditional for boys (CAS) Appropriateness of careers non-traditional for boys (CAS) Femininity (ESRI)		3.9	47.9
8. Emerging gender-role identities	Age Attendance in school during current and previous years Father's occupational level	-	2.7	50.7

Table 36

Summary of Factor Analysis Results for Seventh Graders
(continued)

Factor	Variables Loading at .30 or Greater	Direction (if negative)	Percent of Total Variance	Cumulative Variance
	Mother's encouragement to pursue nontraditional non-science careers (PICP-Q)	-		
	Mother's encouragement to pursue nontraditional activities for girls (PICP-Q)	-		
	Masculinity (ESRI)			
	Femininity (ESRI)			
9. Social influence of peers in science	Science sociogram - all questions		2.7	53.3
10. Influence of significant others on plans to pursue science	Ask boy friend (SOI)	-	2.4	55.8
	Ask sister (SOI)			
	Plans to take math (PICP-Q)			
	Plans to take science (PICP-Q)			
	Plans to graduate from high school (PICP-Q)			
	Plans to attend college (PICP-Q)			
	Interest in taking science (PICP-Q)			
	Interest in taking math (PICP-Q)			
	Interest in careers that require science and math (PICP-Q)			
	Father's expectations for student to pursue career (PICP-Q)			
	Mother's expectations for student to pursue career (PICP-Q)			
	Femininity (ESRI)			

Table 36

Summary of Factor Analysis Results for Seventh Graders
(continued)

Factor	Variables Loading at .30 or Greater	Direction (if negative)	Percent of Total Variance	Cumulative Variance
11. Achievement and Aptitude California Achievement Test - Reading	SFTAA Cooperative Achievement Test Developing Cognitive Abilities - Verbal - Quantitative - Spatial		2.3	58.1
12. Traditionally feminine sources of influence on pursuing science	Father's occupation (scientific or not) Number of brothers Number of sisters Career plans Grades in social studies from previous year Ask father for advice for pursuing science Ask school counselor for advice for pursuing science Ask girl friends for advice for pursuing science Ask sister for advice for pursuing science	- - - -	2.0	60.1

between the self concept instruments: the API and SURPO. Additionally, science attitudes (SO), loaded very high on this factor. The next factor, school performance, loaded with variables originating from grades. Interestingly, the previous year's grades loaded negatively with the current year's grades. All subscales of the SAS loaded on factor 6. These subscales are measures of bias towards girls' participation in science. The influence of career appropriateness for both genders is reflected in factor 7. Age and perceptions of femininity and masculinity loaded on factor 8, along with negative loadings for variables relating to mother's encouragement to pursue nontraditional careers and activities. Peer influence, ideal best friend, real best friend, and friend to work with in science, were major influences on factor 10. Aptitude and achievement (particularly in science) characterized factor 11. The last factor (12) appears to show the influence of traditionally feminine sources (i.e., grades in social studies, influence of girl friends and sisters).

Which of these factors discriminates between the genders? Table 37 contains the summary of the only statistically significant discriminant function when the criterion groups were males and females. A total of eight of the factor scores entered the function, yielding a cumulative Wilks' lambda of .096. The factor score which had the greatest impact was factor 3 (Students' perception of parents' influence on traditional/nontraditional pursuits in science). The factors which did not enter this function were factors 2, 8, 11, 12. The discriminant function was capable of correctly predicting 98.6% of the cases (see Table 40).

The only statistically significant discriminant function for distinguishing between black and white students is summarized in

Table 38. A total of six factors entered in the function, yielding a cumulative Wilks' lambda of .557. Three factors, 2,12, and 8, had the largest standardized coefficients. These factors related to family size and level of achievement, traditionally feminine sources of influence, and emerging gender-role identities. This discriminant function was capable of correctly predicting about 84.5% of the cases correctly.

Finally, criterion groups were formed of the gender and race combinations (e.g., black females, white females). The discriminant analysis resulted in three statistically significant discriminant functions, although the first function accounted for 91.6% of the total explained variation. A total of ten of twelve factor scores entered in the three functions. The only factor scores not in the function were factors 7 and 9. The three functions are summarized in Table 39. The first discriminant function yielded a cumulative Wilks' lambda of .044. The factors having the greatest influence were factor 3 (parents' influences on traditional/nontraditional pursuits related to science), factor 1 (parent influences), and factor 6 (bias toward girls' participation in science). This function could classify about 85% of the cases correctly.

Eighth Grade

For the eighth grade, the twelve factors obtained may be labeled as follows:

1. Achievement and aptitude and gender-role perceptions
2. Students' perceptions of parents' influence on traditional/nontraditional pursuits in science
3. Attitudes towards self (particularly in science and math)

Table 37

Summary of Discriminant Functions for Gender Groups on Factor Scores for Seventh Grade

Entry	Discriminant Function Variables[1]	Standardized Coefficients	Cumulative Wilks' Lambda	Chi-Square	df	Probability
1	Factor 3	1.081	.116	343.95	8	.0000*
2	Factor 1	0.354	.108			
3	Factor 6	0.255	.102			
4	Factor 7	-0.147	.100			
5	Factor 10	-0.134	.099			
6	Factor 5	0.107	.098			
7	Factor 9	-0.104	.097			
8	Factor 4	0.090	.096			

[1]Order of variables reflects order of entry in discriminant run.

Overall canonical correlation = .951.

*Significant at .05 level.

Table 38

Summary of Discriminant Functions for Race Groups on Factor Scores for Seventh Grade

Entry	Discriminant Function Variables[1]	Standardized Coefficients	Cumulative Wilks' Lambda	Chi-Square	df	Probability
1	Factor 2	.863	.603	85.955	6	.0000
2	Factor 12	.403	.624			
3	Factor 8	-.341	.593			
4	Factor 11	-.229	.579			
5	Factor 10	.207	.567			
6	Factor 4	.196	.557			

[1]Classifications for gender and race combinations based on first discriminant function only.

Overall canonical correlation = .655.

Table 39

Summary of Discriminant Functions for Gender and Race Groups for Factor Scores for Seventh Grade

Entry	Discriminant Function Variables[1]	Standardized Coefficients Function 1	Function 2	Function 3	Cumulative Wilks' Lambda[2]	Function	Chi-Square	df	Probability
1	Factor 3	1.100	.032	-.029	.110	1	450.66	30	.0000*
2	Factor 2	-0.088	.838	.359	.072	2	102.33	18	.0000*
3	Factor 1	0.373	.133	-.168	.063	3	16.32	8	.0381*
4	Factor 12	-0.083	.429	-.399	.058				
5	Factor 6	0.269	-.058	.103	.054				
6	Factor 4	0.036	.226	-.569	.051				
7	Factor 8	0.049	-.335	.186	.049				
8	Factor 11	0.094	-.252	.337	.046				
9	Factor 5	0.107	-.017	-.428	.045				
10	Factor 10	-0.063	.156	.348	.044				

[1]Order of variables reflects order of entry for first discriminant function.

[2]Values are for first discriminant function only.

Overall canonical correlation = .954 for first discriminant function, .671 for second discriminant function and .327 for the third discriminant function.

*Significant at .05 level.

Table 40

Summary of Classification Rates for Discriminant Analyses[1] on Factor Scores for Seventh Grade

Group	Number of Cases	Classification Correct	Incorrect
Female	75	73 (97.3%)	2 (2.7%)
Male	78	78 (100%)	0
White	59	49 (83.1%)	10 (16.9%)
Black	93	80 (86.0%)	13 (14.0%)
White Female	28	25 (89.3%)	3 (10.7%)
Black Female	47	40 (85.1%)	7 (14.9%)
White Male	31	25 (80.6%)	6 (19.4%)
Black Male	46	39 (84.8%)	7 (15.2%)

[1]Classifications for gender and race combinations based on first discriminant function only.

4. Bias towards girls participating in science
5. Perceptions of career appropriateness for the genders
6. Traditional expectations for females
7. Parental encouragement for traditional/nontraditional careers
8. School performance
9. Social influence of peers
10. Family sources of traditional/nontraditional influences in pursuing science
11. Influences of significant others in pursuing science
12. Self and parental influence on pursuing science (see Table 41).

These twelve factors, collectively, show an increase in the perceptions of the students' attitudes toward gender roles and traditional/nontraditional pursuits in science. For the eighth grade, factor 1 was composed of variables related to achievement, aptitude, and gender-role perceptions. This factor accounted for 12.9% of the total variance. Factor 2 remained comparable to factor 3 from the previous year, although the factor accounted for more variance during the second year. Factor 3, the self concept measures, continued to be a prominent factor. It contributed slightly more variance during the second year than it had for the first year. The same trend held for factor 4 (previous year, factor 6). Career appropriateness variables influenced factor 5, which loaded variables quite similarly to factor 7 from the previous year. However, for the eighth graders, this factor contributed 7.9% of the variance as opposed to 3.9% the previous year. Factor 6 appeared to describe traditional feminine expectations. Parental encouragement variables, particularly related to careers, characterized

Table 41

Summary of Factor Analysis Results for Eighth Graders

Factor	Variables Loading at .30 or Greater	Direction (if negative)	Percent of Total Variance	Cumulative Variance
1. Achievement and aptitude and gender-role perceptions	Number of brothers	-	12.9	12.9
	California Achievement Test Battery (language, math, reading)			
	SFTAA			
	Socioeconomic status (income)	-		
	Grades from previous year in math			
	Grades from previous year in science			
	Grades from previous year in social studies			
	Grades from current year in language arts			
	Cooperative Science Test			
	Developing Cognitive Abilities Test			
	- Verbal			
	- Quantitative			
	- Spatial			
	Masculinity (ESRI)			
	Femininity (ESRI)			
2. Students' perceptions of parents' influence on traditional/non-traditional pursuits in science	Male dominance in ability/leadership/achievement (SPS)		8.5	21.4
	Ask boy friends for advice in taking science (SOI)			
	Father's encouragement for pursuing traditional science careers			
	Father's encouragement for pursuing nontraditional science careers	-		

Table 41

Summary of Factor Analysis Results for Eighth Graders
(continued)

Factor	Variables Loading at .30 or Greater	Direction (if negative)	Percent of Total Variance	Cumulative Variance
	Mother's encouragement for pursuing traditional science careers			
	Mother's encouragement for pursuing nontraditional science careers	-		
	Father's encouragement in taking advanced science and math courses			
	Father's encouragement in taking basic science and math courses	-		
	Mother's encouragement in taking advanced science and math courses			
	Mother's encouragement in taking basic science and math courses	-		
	Mother's encouragement of activities traditional for girls			
	Mother's encouragement of activities nontraditional for girls	-		
	Femininity (ESRI)			
3. Attitudes toward self in school; particularly science and math	Self concept in school (SURPO)		6.7	28.1
	Self as student (SURPO)			
	Perception of teacher (SURPO)			
	Social perceptions (SURPO)			
	Science attitudes (SO)			
	Self concept-Overall (API)			
	Self concept in math (API)			
	Self concept in science (API)			
	Ask girl friends for advice in pursuing science (SOI)	-		
	Interest in science courses (PICP-Q)			

Table 41

Summary of Factor Analysis Results for Eighth Graders
(continued)

Factor	Variables Loading at .30 or Greater	Direction (if negative)	Percent of Total Variance	Cumulative Variance
	Interest in math courses (PICP-Q)			
4. Bias towards girls participating in science	Bias towards girls participating in science (SPS) Male dominance (SPS) Male assertiveness (SPS) Male risktaking (SPS) Male inquisitiveness (SPS) Male expectations (SPS) Males-active/females-passive (SPS) Masculinity (ESRI) Femininity (ESRI)		5.2	33.2
5. Perceptions of career appropriateness for the genders	Social perceptions (SURPO) Career appropriateness for girls (CAS) Career appropriateness for girls in traditional science careers (CAS) Career appropriateness for girls in nontraditional science careers (CAS) Career appropriateness for boys (CAS) Career appropriateness for boys in traditional science careers (CAS) Career appropriateness for boys in nontraditional areas (CAS)	-	4.9	38.1

Table 41

Summary of Factor Analysis Results for Eighth Graders
(continued)

Factor	Variables Loading at .30 or Greater	Direction (if negative)	Percent of Total Variance	Cumulative Variance
6. Traditional expectations for females	Career appropriateness for girls in traditional science careers (CAS)	-	3.8	41.9
	Interest in taking math (CAS)	-		
	Plans for graduating from high school (CAS)	-		
	Plans for attending college (CAS)	-		
	Interest in math (CAS)	-		
	Father's expectation for student to work at a career (CAS)	-		
	Mother's expectation for student to work at a career (CAS)	-		
	Father's encouragement of activities traditional for girls (PICP-Q)	-		
7. Parental encouragement for traditional/ nontraditional careers	Father's encouragement for pursuing nontraditional science careers (PICP-Q)		3.4	45.3
	Father's encouragement for pursuing traditional non-science careers (PICP-Q)			
	Father's encouragement for pursuing nontraditional non-science careers (PICP-Q)			
	Mother's encouragement for pursuing nontraditional science careers (PICP-Q)			

Table 41

Summary of Factor Analysis Results for Eighth Graders
(continued)

Factor	Variables Loading at 30 or Greater	Direction (if negative)	Percent of Total Variance	Cumulative Variance
	Mother's encouragement for pursuing traditional non-science careers (PICP-Q)			
	Mother's encouragement for pursuing nontraditional non-science careers (PICP-Q)			
	Father's encouragement for taking basic science and math courses (PICP-Q)			
	Mother's encouragement for taking basic science and math courses (PICP-Q)			
8. School performance	Attendance in previous year's (sixth) grade	-	3.0	48.3
	Attendance in current year's (seventh) grade	-		
	Previous year's grades in language, math, science, and social studies			
	Current year's grades in language, math, science, and social studies			
9. Social influence of peers in science	Attendance during current year	-	2.7	51.1
	Science sociogram - All subscales			

Table 41

Summary of Factor Analysis Results for Eighth Graders
(continued)

Factor	Variables Loading at .30 or Greater	Direction (if negative)	Total Variance	Cumulative Variance
10. Family sources of traditional/non-traditional influences in pursuing science	Number of sisters		2.5	53.6
	Socioeconomic status (income)			
	Grades in physical education from previous and current years			
	Father's occupational level			
	Career appropriateness for girls in traditional science careers (CAS)			
	Ask father for advice about pursuing advanced science courses (SOI)	-		
	Ask mother for advice about pursuing advanced science courses (SOI)	-		
	Ask sister for advice about pursuing advanced science courses (SOI)			
	Father's encouragement of activities nontraditional for girls	-		
11. Influences of significant others on pursuing science	Number of brothers		2.5	56.1
	Ask school counselor for advice in taking science (SOI)	-		
	Ask teacher for advice in taking science (SOI)	-		
	Ask girl friend for advice in taking science (SOI)			
	Ask brother for advice in taking science (SOI)			
	Ideal best friend (SOC)	-		

Table 41

Summary of Factor Analysis Results for Eighth Graders
(continued)

Factor	Variables Loading at .30 or Greater	Direction (if negative)	Percent of Total Variance	Cumulative Variance
12. Self and parental influence on pursuing science	Self concept in science (API)	-	2.2	58.3
	Ask adult friend for advice in taking science			
	Leadership on science experiment (SOC)	-		
	Interest in taking science (PICP-Q)			
	Father's encouragement to become a scientist (PICP-Q)			
	Mother's encouragement to become a scientist (PICP-Q)			
	Father's encouragement of activities traditional for girls (PICP-Q)	-		
	Father's encouragement of activities nontraditional for girls (PICP-Q)	-		

factor 7. Factor 8, school performance, was characterized by grades and absences from school. Social influence of peers, factor 9, remained consistent with the seventh graders' factor 9. Family variables, such as number of sisters, income, father's occupational level, loaded with variables relating to influence of significant others for pursuing science (factor 10). The influence of significant others was the dominant characteristic of factor 11. This factor had negative loadings for school counselor and teacher as sources of influence for pursuing science. Finally, factor 12, shows the influence of self concept, interest in science, and parental encouragement.

Discriminant analyses were again conducted on the factor scores for the second year. Table 42 contains the summary of the only statistically significant discriminant function when the criterion groups were males and females. A total of eight of the factor scores entered into the function, yielding a cumulative Wilks' lambda of .106. The factor scores having the greatest impact in the overall function were factors 2 and 7, followed by 9 and 3. Factor 2, students' perceptions of parents' influence on traditional/nontraditional pursuits in science, made the greatest difference between the genders -- as it did the first year. Factors not entering the function were factors 5 and 8. The discriminant function was capable of correctly predicting about 98% of all the cases (see Table 45).

The only statistically significant discriminant function for distinguishing among black and white students is summarized in Table 43. A total of six factors (i.e., 1, 10, 5, 6, 7, 4) entered in the function, yielding a cumulative Wilks' lambda of .440. Factor 1, achievement and aptitude and gender-role perceptions, had the largest standardized

Table 42

Summary of Discriminant Function for Gender Groups on Factor Scores for Eighth Grade

Entry[1]	Discriminant Function Variables	Standardized Coefficients	Cumulative Wilks' Lambda	Chi-Square	df	Probability
1	Factor 2	1.128	.148	307.97	8	$p < .0001$
2	Factor 7	-0.504	.123			
3	Factor 9	0.231	.118			
4	Factor 3	0.206	.114			
5	Factor 1	-0.194	.111			
6	Factor 4	-0.158	.109			
7	Factor 11	0.150	.107			
8	Factor 6	-0.109	.106			

[1]Values represent order of entry.

Table 43

Summary of Discriminant Function for Race Groups on Factor Scores for Eighth Grade

Entry[1]	Discriminant Function Variables	Standardized Coefficients	Cumulative Wilks' Lambda	Chi-Square	df	Probability
1	Factor 1	-.881	.628	112.44	6	$p < .0001$
2	Factor 10	.669	.489			
3	Factor 5	.267	.472			
4	Factor 6	.254	.458			
5	Factor 7	.215	.447			
6	Factor 4	.166	.440			

[1]Values represent order of entry.

Table 44

Summary of Discriminant Function for Race and Gender Groups on Factor Scores for Eighth Grade

Entry[1]	Discriminant Function Variables	Standardized Coefficients Function 1	Function 2	Cumulative Wilks' Lambda	Chi-Square[2]	df	Probability
1	Factor 2	1.139	.009	.145	426.33	30	$p < .0001$
2	Factor 1	-0.088	-.887	.089	118.06	18	$p < .0001$
3	Factor 10	0.042	.675	.068			
4	Factor 7	-0.543	.195	.055			
5	Factor 3	0.243	.054	.051			
6	Factor 9	0.224	-.036	.049			
7	Factor 6	-0.123	.256	.047			
8	Factor 4	-0.178	.156	.045			
9	Factor 5	0.020	.265	.043			
10	Factor 11	0.161	-.104	.042			

[1]Values represent order of entry.

[2]Values are for the first two functions only.

Overall canonical correlation for the first function is .949 and .752 for the second.

Table 45

Summary of Classification Rates for Discriminant Analyses[1] on Factor Scores for Eighth Grade

Group	Number of Cases	Classification	
		Correct	Incorrect
Female	71	71 (100%)	0 (0%)
Male	72	69 (95.6%)	3 (4.2%)
White	57	50 (87.7%)	7 (12.3%)
Black	85	75 (88.2%)	10 (11.8%)
White Female	27	24 (88.9%)	3 (11.1%)
Black Female	44	40 (90.9%)	4 (9.1%)
White Male	30	25 (83.3%)	5 (16.6%)
Black Male	41	33 (80.5%)	8 (19.5%)

[1]Classifications for gender and race combinations based on first discriminant function only.

coefficient. Factor 10, family sources of traditional/nontraditional influence in pursuing science, had the next largest impact in the function. The discriminant function was capable of predicting 88% of the cases correctly (see Table 45).

Finally, criterion groups were formed of the gender and race combinations (e.g., black females, white females). The discriminant analysis resulted in two statistically significant discriminant functions, although the first function accounted for 86.9% of the total explained variation. A total of ten of twelve factor scores entered in both functions. The only factor scores not in either function were factors 8 and 12. The two functions are summarized in Table 44. The first discriminant function yielded a cumulative Wilks' lambda of .042. The factor having the largest standardized coefficient in the first function was factor 2, students' perceptions of parents' influences on traditional/nontraditional pursuits in science. The factor making the next greatest impact was factor 7, another parental encouragement factor. This first discriminant function could correctly classify 85.9% of the cases.

In summary, relative to all variables investigated in this study, the factor which had the greatest impact discriminating between the genders during the seventh grade and the eighth grade was the factor dealing with students' perceptions of parents' influences on traditional/nontraditional pursuits in science. Many of the variables supporting these factors (factor 3 in the seventh grade and factor 2 in the eighth grade analyses) came from the PICP-Q (see Appendix A). For both years, parental encouragement (from factors 1 from the first year, and factor 7 from the second) was the factor which had the next largest impact on

the discriminant function for gender groups. For the seventh grade students, bias towards girls participating in science (factor 6), made the next greatest contribution to the significant function. However, for eighth graders, social influence (factor 9) and the self concept variables (factor 3) made the next greatest contribution to the significant function.

Research Question Nine

This final question relates all variables over the two year period.

Are there differences for separate subgroups of males and females between the seventh and eighth grades on variables associated with social and academic interactions in the classroom, self concept in science, sex role attitudes, concepts of career appropriateness, attitudes toward science, achievement and aptitude for science, and perceived influence of significant others on science interests?

This question asking, simply, whether the males and females, respectively, changed in cognitive and affective behaviors as associated with science over the one year of maturation, was answered by data derived from a discriminant analysis multivariate technique. Variables used as potential discriminators in the behavior of the adolescents were 103 separate measures of behavior observed in responses to the total battery of instruments used in this study, as well as those recorded from classroom observations. Separate discriminant analyses models were run on data from the male and female subsamples, respectively. A discriminant function describing a set of variables significantly differentiating between the females in the seventh grades and the females in the eighth grade at the .01 level of significance was derived. Another function discriminating between the males at the two grade levels was also demonstrated to be significant at the .01 level (see Table 46).

Variables Discriminating between Seventh and Eighth Grade Females

In Table 47 are given the standardized discriminant coeffi-

Table 46

Results of Discriminant Models Showing Changes in Male and Female Characteristics Between Seventh and Eighth Grades

Gender	Eigenvalue	Canonical Correlation	R^2	Wilks' Lambda	df	Chi Square
Females	2.77	.86	.7396	.27	38	173.86**
Males	3.22	.87	.7569	.24	38	197.22**

**Significant at $\alpha = .01$.

Table 47

Variables Discriminating Between Females in the Seventh and Eighth Grades

Variables	Standardized Discriminant Coefficient	Univariate F Ratio	Direction-ality of Change
Attitudes toward Science (SO)	.43	26.14**	8 < 7
Feedback-Simple acknowledgment	.22	.64	8 < 7
Feedback-Clarification	.59	9.28**	8 < 7
Self Concept in Mathematics (API)	-.43	2.92	8 > 7
Grades in mathematics	1.06	3.45	8 < 7
Grades in science	-1.02	.08	8 > 7
Interest in science course (PICP-Q)	.64	4.37*	8 < 7
Significant others-male friends (SOI)	-.15	5.65*	8 > 7
Interest in math course (PICP-Q)	-.06	.80	8 > 7
No response from teachers	-1.04	.97	8 > 7
Incorrect answers to questions	-.43	1.28	8 < 7
Feedback-elaboration	.41	1.74	8 < 7
Student Response Time	.15	4.18*	8 < 7
Type Classroom Interaction-business	.54	5.21*	8 < 7
Appropriateness Trad. Science Careers-boys	.54	5.21*	8 > 7
Mothers' Nontraditional Science Career Expectations (PICP-Q)	.27	.93	8 < 7
Fathers' Trad. Science Career Expectations-Girls (PICP-Q)	-.21	.37	8 < 7
School absences	-.48	1.27	8 > 7
Peer Status-Best Friend (SOC)	.07	.26	8 < 7
Learning Domain-Information	2.98	3.89*	8 > 7
Correctness of Answers to Questions	-.42	13.53**	8 > 7
Significant Others-Fathers (SOI)	-.16	.02	8 > 7
Self Concept in Science (API)	.17	5.06*	8 < 7
Fathers' Encouragement in Nontradi-tional Activities (PICP-Q)	.49	2.10	8 > 7
Mothers' Encouragement in Nontradi-tional Activities (PICP-Q)	-.40	.06	8 > 7
Mothers' Expectations-Traditional Science Careers	.41	.10	8 < 7
Career Appropriateness-Traditional Girls (CAS)	.32	.81	8 < 7
Classroom Feedback-Criticism	.27	4.68*	8 < 7
Aptitude-Spatial Relations	.47	.54	8 > 7
Aptitude-Quantitative	1.51	8.39**	8 > 7
Classroom Interaction Source-Teacher to Student	-3.15	4.64*	8 > 7
Absence of Feedback	.63	.02	8 > 7
Type Interaction-Solicited Responses	1.08	4.61*	8 > 7
No. science courses planned	-.36	4.37*	8 < 7
Learning Domain-Affective	.27	3.89*	8 > 7
Fathers' Career Expectations-Nontraditional Science (PICP-Q)	.21	.04	8 < 7
Significant Others-Adult Friend (SOI)	-.16	.16	8 > 7

*Significant at .05 level **Significant at .01 level

cients for 39 separate variables which yielded a canonical correlation of .86 and a Wilks' lambda of .27 for differentiating between females while enrolled in seventh grade science and these same females enrolled later as eight graders. The relative influence of each variable upon the discriminant function can be observed by an examination of the standardized discriminant coefficient for that variable when the directionality of the coefficient is ignored. Table 47 also gives univariate F ratios obtained when comparing means for the two respective years in an initial analysis conducted prior to derivation of the discrimination function. Thus, an analysis can be made of the total profile of traits discriminating between the same group of girls at the two grade levels.

Within the female group 14 of the variables loading to the discriminant function were found to yield significant F ratios prior to computation of the multivariate function. Twenty-three other variables were found to be associated with these initial discriminating variables in the multivariate function in differentiating between the characteristics of the girls in the seventh and eighth grades.

In the univariate analysis, the girls as eighth graders were found to have less positive attitudes toward science, lower self concepts in science, less interest in current science course and lower estimations of the number of science courses planned to be elected in high school. Meanwhile, the quantitative aptitude for the girls improved significantly between seventh and eighth grades. In eighth grade science classes, the girls received less negative feedback related to criticism. They also received less clarification of their answers from teachers. The girls, as eighth graders, answered more

questions correctly, gave more solicited responses to teachers' questions and gave their responses more quickly. They were more involved in teacher to student interactions concerning learning tasks associated with the information and affective domains and were less involved in class interactions which were not instructional related (class business). The girls as eighth graders recognized as more important the influence of male friends as significant others giving input to their decision whether to elect advanced science courses in high school.

In the discriminant function, it was discovered that the significant decline in attitudes toward science of the girls in the eighth grade was accompanied by a decrease in their math grades while their attitudes toward self in mathematics improved. It was felt, however, that these observations relative to mathematics may have been an artifact of the sample used. Two of the eighth grade teachers in mathematics were women widely recognized for their effectiveness in motivating students to study mathematics. It was observed, however, that the girls' aptitude for spatial relations had improved since their testing as seventh graders.

The discriminant factor also revealed different perceptions of parental influences for the girls at the two grade levels. In the eighth grade, the girls viewed their fathers as having lower expectations of their pursuing nontraditional sceince courses than they had felt in the seventh grade. At the same time, the fathers' position as a "significant other" in decisions relating to scheduling more science classes came to be more positively recognized. Mothers were viewed by the eighth grade girls as being less supportive of both traditional and nontraditional careers in science for girls than had been perceived at

the seventh grade level. In general, parents were seen as less supportive of careers in science by their daughters as the girls advanced from seventh to eighth grade. The eighth grade girls, for example, recorded more support from both parents for participation in activities considered nontraditional for girls (e.g., riding motorcycles, using tools).

Very few differences were discovered in gender-role perceptions for the girls as seventh and eighth graders. Their attitudes toward the appropriate role for males and females in science activities did not change. They did not change in their self perceptions of personal traits relative to the masculinity-femininity stereotype. In the eighth grade, however, the girls tended to feel more that males should enter career areas in science traditionally dominated by men. At the same time, they felt more positively than they had in the seventh grade that nontraditional careers were appropriate for women.

In the discriminant function, the nature of the change taking place in classroom interactions between the girls as seventh graders and as eighth graders also came to be more evident. As eighth graders, the girls gave fewer incorrect answers. Therefore, they were not subjected to so much feedback for teachers giving criticisms, seeking clarification, or elaborating their answers.

In general, then, as the girls matured they developed less interest in science and demonstrated less self identification with science. While improving in quantitative and spatial relations abilities, they came to express less interest in electing future science courses. They received less feedback as eighth graders, but much of the feedback differences appeared to be associated with the eighth grade girls' answering fewer questions incorrectly and thus not requiring feedback related

to criticism, clarification, or elaboration. The influence of male friends on their science activities were felt more strongly by the girls as eighth graders. The girls in the eighth grade also perceived both parents as being less supportive of careers in science for girls. The older girls' feelings, however, that nontraditional careers for women in science were appropriate had increased, but, as the girls matured, they felt more strongly that men should enter career areas in science traditionally dominated by men.

Variables Discriminating between Seventh and Eighth Grade Males

Only eight of the 102 variables in the potential discriminant set showed significant differences in the characteristics of the males as seventh and eighth graders. Prior to the multivariate analysis, the eighth grade males, as compared to themselves in the seventh grade, were seen as having lower attitudes toward science and lower perceptions of self in relation to teachers. The males, however, had also significantly improved their quantitative aptitudes. In classroom interactions, the males as eighth graders received more disciplinary attention from the teachers. They received less clarification in feedback during that year. As eighth graders, the males responded more quickly to teachers' questions and the teachers waited longer in giving response to them. Males participated less often by giving fewer unsolicited responses to questions or comments in class (see Table 48).

In the discriminant analysis other variables were found to be associated with the differences in characteristics observed for the male group as seventh and eighth graders. The most evident association was their changing perspectives of the influence of significant others on their decision to elect science courses in high school. The role of

the mother, sisters and adult friends appeared more influential to the males as eighth graders than as seventh graders in assisting them in their decision of whether to take advanced courses in science in high school. The influence of school counselors and the peer group (both male and female) was felt less important as the males matured for one year. The eighth grade males also perceived the expectations of both parents for them to enter careers in science to be lower than they were perceived when the boys were seventh graders.

The males appeared to have improved somewhat in general self concept and described more personal traits traditionally classified as masculine for themselves.

Relative to classroom interactions, the multivariate function contributed several other observations associated with those already reported from the univariate analysis. Fewer teacher-to-student classroom interactions were also observed for the males as eighth graders than as seventh graders. They also received less praise and elaboration as eighth graders, but they did receive more criticism and simple acknowledgment of responses from the teacher.

In general, then, the males as eighth graders expressed less positive attitudes toward science, but they did not change in their attitudes toward self in sceince and their interest in electing advanced courses in science. They did display more difficulty with teachers as illustrated in their identification of more negative self-teacher relations, as well as in the increase in disciplinary feedback which they were observed to receive. The males as eighth graders identified for themselves more positively a set of personal traits traditionally stereotyped as masculine than they did as seventh graders. The eighth

grade males appeared to perceive less support from parents for pursuance of careers in science than they did in the seventh grade. The perceptions of significant others relative to science for the males also seemed to have shifted more toward mothers, sisters and adult friends, in contrast to school counselors and the peer group. The males did respond more quickly to teachers' questions and teachers waited longer to give their feedback.

Table 48

Variables Discriminating Between Males in the Seventh and Eighth Grades

Variables	Standardized Discriminant Coefficient	Univariate F Ratio	Direction-ality of Change
Self-Teacher Perceptions (SURPO)	.38	9.98**	8 < 7
Attitudes toward Science (SO)	.35	15.71**	8 < 7
General Self Concept (API)	-.39	.15	8 > 7
Significant Other-Mother (SOI)	-.28	.33	8 > 7
Significant Other-School Counselor (SOI)	-.18	.03	8 < 7
Significant Other-Male friends (SOI)	-.23	.05	8 < 7
Significant Other-Female friends (SOI)	-.26	1.25	8 < 7
Significant Other-Sisters (SOI)	-.26	.19	8 > 7
Significant Other-Adult friends (SOI)	.18	.16	8 > 7
Aptitude-Verbal (DCAT)	.35	.32	8 > 7
Aptitude-Quantitative (DCAT)	-.61	4.34*	8 > 7
Fathers' Encouragement to be Scientist (PICPQ)	-.16	2.09	8 < 7
Fathers' Career Expectations-Nontraditional Science (PICPQ)	.57	.39	8 < 7
Fathers' Career Expectations-Nontraditional Nonscience (PICPQ)	.60	.21	8 < 7
Mothers' Career Expectations-Nontraditional Science (PICPQ)	-1.20	3.61	8 < 7
Mothers' Career Expectations-Nontraditional Nonscience (PICPQ)	-.36	.78	8 < 7
Fathers' Encouragement-Traditional Activities (PICPQ)	-.68	.22	8 < 7
Fathers' Encouragement-Nontraditional Activities (PICPQ)	.66	.62	8 < 7
Mothers' Encouragement-Traditional Activities (PICPQ)	.82	.28	8 < 7
Mothers' Encouragement-Nontraditional Activities (PICPQ)	-.56	2.91	8 < 7
Masculinity (ESRI)	.50	1.84	8 > 7
Classroom Interaction Source-Teacher to Student	1.81	2.93	8 < 7
Classroom Interaction-Disciplinary	.53	4.40*	8 > 7
Type Interaction-Unsolicited Response	.53	13.20**	8 < 7
Feedback-Simple Acknowledgment	-1.14	.82	8 > 7
Feedback-Praise	-.68	.38	8 < 7
Feedback-Clarification	-.27	9.70**	8 < 7
Feedback-Criticism	-.19	1.85	8 > 7
Feedback-Elaboration	.23	3.63	8 < 7
Student Response Time	.26	23.76**	8 < 7
Teacher Wait Time	.50	7.59**	8 > 7
Learning Domain Elicited-Information	1.33	.45	8 < 7
Learning Domain Elicited-Attitudes	.16	.66	8 < 7
Incorrect Answers to Questions	-.49	.02	8 < 7

*Significant at .05 level **Significant at .01 level

SUMMARY OF RESULTS

The results of this study relative to all nine research questions are summarized in the following sections.

Classroom Interactions

During both years of the study male adolescents on the average received more attention from teachers than did females. As seventh and eighth graders, the males participated in significantly more class interactions in general. They also were asked more instructional questions during each of the two years. Males and females also differed significantly in the types of interactions in which they participated; i.e., males participated more in classroom business, disciplinary and social interactions, as well as instructional interactions. The only interaction category in which females exceeded males was that of solicited responses. It was concluded that girls gave more responses in class associated with teacher solicitation related to prepared materials and that boys displayed more aggressiveness and spontaneity in both instructional (call outs) and noninstructional interaction.

No significant differences were discovered in the types of feedback given to males and females in the seventh grade by science teachers. Differences, however, in type of feedback given by teachers were noted for the gender groups as eighth graders. Boys, in general, received more types of structured feedback (i.e., prompting, clarification, elaboration). On the other hand, there were also more incidences of males receiving no teacher feedback to their responses. In general, it appeared that boys received a broader range of teacher feedback which

served to prolong the amount of interaction between teacher and student. This prolongation appeared to provide the boys intermediate support to their responses, giving them more opportunity to answer the questions correctly.

Self and Sex Role Relative to Science Attitudes

Those adolescents of both gender groups who liked science increased their stereotypical views of male dominance in science activities. Both gender groups, however, who reported positive attitudes toward science came to accept more career areas in science as appropriate for both males and females. It appeared, then, that those interested in science were able to accept the appropriateness of careers in science for both males and females, but at the same time, also accept the prevailing stereotype of male dominance in science classroom activities. For both gender groups who liked science, their self concepts in the school setting remained positive over the course of the study. However, the self concepts in science for both groups decreased relative to their science attitudes. The same trend held for the girls' self concept in mathematics (i.e., it went down), but for the boys, self concept in mathematics increased relative to their attitudes toward science.

Relationship of Classroom Interactions to Social/Self Concept

Canonical roots relating perceived self/social/gender role/parental expectations to observed classroom interactions displayed more complex patterns of behavior for girls in the seventh grade than as eighth graders. In general, a lack of parental support for girls to pursue advanced courses in high school science was associated with

fewer classroom interactions of all types. Girls who were selected by the peer group as desired leaders of science experiments were those who saw themselves as having good self-social relations. Other traits associated with these peer leaders were views of more careers in science as being appropriate for women and lower self-teacher perceptions. These socialized girls had fewer classroom interactions and received either more nonfeedback or feedback in the form of simple acknowledgment or restatement of response.

A race interaction was also observed for females in the seventh grade. A group of girls composed more of blacks was chosen as best friends by the peer group. These girls accepted the stereotype of male assertiveness in science activities, but also felt that fewer careers in science were appropriate for males. This female group received less feedback within classroom interactions in science.

In the eighth grade, the parameters for acceptance of an alpha (type I) error had to be lowered to the .10 level for a significant relationship to be indicated between girls' perceptions of self/gender role/social/parental expectation behaviors and then observed classroom interactions. At that level, it was observed that girls who had more positive self-social perceptions in school and more overall self concept tended to have less parental support for studying advanced courses in science. These girls also had fewer classroom interactions, received less feedback, but answered more of both instructional and noninstructional questions in class. They also held stereotypical views of male assertiveness in science, but they did not view males as more risk-taking or more inquisitive.

In reverse to the girls, the more complex relationship between observed classroom interactions for boys and their science related self/gender role/social traits/parental expectations were observed in the eighth grade, rather than the seventh grade. Those males from relatively higher income families participated in more classroom interactions. For those boys whose fathers were not seen as supportive of advanced studies in science, regardless of parent income level, less teacher support in feedback was observed.

Relationship of Aptitude and Achievement Variables to Attitudes toward Science

Relatively low correlations were observed between measures of science achievement/aptitude and the attitudes of both males and females toward science. Spatial relations abilities were found to be correlated with girls' attitudes toward science at both grade levels, but the directionality of the relationship reversed; i.e., those girls with more positive attitudes scored lower on spatial abilities in the seventh grade, but scored higher on this measure in the eighth grade.

Gender Group Differences in Attitudes/Aptitude and Achievement

During both grades girls expressed more positive attitudes toward science but scored lower than did boys on a standardized achievement test in science. The boys earned higher grades in the seventh grade, but the girls made higher grades as eighth graders.

Relationship of Gender Groups' Self Concept/Sex-Role Perceptions to Science Attitudes and Achievement

A shift in patterns of behavior related to science attitudes and

and achievement developed for both males and females between the seventh and eighth grades. In the seventh grade a pattern in which gender role/self concept variables were found to be associated with both positive attitudes and higher achievement in science for boys. Those boys who liked science and scored high on standardized tests were those with higher self concepts in science. They also felt that males were more inquisitive, but not more assertive, than females in science.

In the seventh grade female group, the relationship which appeared most observable was between positive attitudes toward science and more positive attitudes toward self as a student, more negative views of male expectation in science and views of fewer careers in science as appropriate for males.

As eighth graders, females with lower attitudes, lower grades and higher achievement in science as measured by standardized tests had lower concepts of self as student and low self-social perceptions. They did not see males as more assertive in science but did view their personal traits as more congruent with the masculine stereotype.

Male eighth graders with lower attitudes toward science but higher achievement were those whose concepts of self as students were lower, but whose concepts of self-social relations were higher. These students had lower self concepts in mathematics and rated themselves as having more masculine traits.

Gender Group Differences Related to all Variables

Relative to all variables investigated in the study, the factor which had the greatest impact on discriminating between gender groups dealt with students' perceptions of parental influences on traditional/

nontraditional pursuits in science. This factor had the greatest impact on the discriminant function for the seventh and eighth grade results. For both years, the factor which made the second largest contribution also dealt with parental influences. During the seventh grade, the factor dealing with bias toward girls participating in science made the third largest contribution to the discriminant function. This same factor had less influence on the discriminant function during the eighth grade. Instead, factors (beyond the parental influence factors) contributing to the discriminant function for the eighth grade dealt with social influence in the classroom and self concept variables.

Characteristics Discriminating Between Seventh and Eighth Grade Females and Males

Eighth grade girls displayed less interest in science and less self identification with science. Although their quantitative and spatial skills improved, they indicated less interest in pursuing science further in high school. The girls as eighth graders received less feedback but also answered fewer questions incorrectly. The influence of male friends on their potential decisions to study science was more strongly perceived by the girls as eighth graders. These eighth grade girls reported less parental support of careers in science. As the girls matured, they felt more strongly that nontraditional careers in science were more appropriate for women and less appropriate for males.

The males as eighth graders expressed less positive attitudes toward science, but they did not change in their attitudes toward self in science and their plans to elect advanced science courses. They

had fewer teacher-to-student interactions and received more negative forms of feedback. Additionally, they characterized themselves as having more masculine stereotyped traits. The eighth grade males perceived less support from parents for entering science careers. Influence of significant others shifted from the peer group to family and other adults. Additionally, the males as eighth graders responded more quickly to teachers' questions. Teachers also waited longer to give them feedback.

Conclusions

The broad purpose of this study was to relate gender differences, particularly those associated with self concept and gender-role perceptions to science attitudes and achievement, and to influences of significant others. These relationships were then examined in terms of how they might have an impact on understanding why more adolescent girls do not participate in science.

Given the rural setting and very traditional, teacher-centered classrooms used in this study, differences did emerge within the course of the fifteen months that the students participated in the study. First, males did receive more forms of interaction, either positive or negative. Second, for most of the research questions, the patterns of results became more complex for the male eighth graders and less complex for the female eighth graders. This was in opposition to the seventh grade results. Third, students of either gender who liked science came to have more biased attitudes towards girls' participation in science from the seventh to the eighth grade. However, of all the variables studied from year one to two, the factor that discriminated

each year between the gender groups related to students' perceptions of parental influences on traditional/nontraditional pursuits of science. Fourth, as the girls matured they had less interest in science and less self identification in science. Last, while the male eighth graders also expressed less positive attitudes toward science, they did not change in their attitudes toward self in science and their plans to elect science courses.

In conclusion, this study has been an attempt to investigate the influences that are at work during the critical adolescent years which affect girls' participation in science. Although a great deal of time and hard work have gone into this study, it is only a beginning in an area in which no other large studies have been conducted. There are clearly some differences at work between these adolescents relative to science participation. It is hoped that the insights gained from this study will encourage more research.

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[1]Beggs, D. Personal communication, October 15, 1981.

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Appendix A

Science Participation Scale

ID _____

Below are some sentences. Read each sentence and decide how you feel. Circle the words which describe how you feel. Try your best to decide whether you agree or disagree. Do not mark "don't know" unless you really cannot decide how you feel about an item.

Example: I like to do science experiments in class.

strongly agree	agree	don't know	disagree	strongly disagree

---

1. A girl would be more trusted than a boy would be to pour a dangerous chemical in an experiment.

strongly agree	agree	don't know	disagree	strongly disagree

2. Teachers encourage girls to study science more than they encourage boys.

strongly agree	agree	don't know	disagree	strongly disagree

3. Girls are more willing than boys are to defend their ideas in class discussions.

strongly agree	agree	don't know	disagree	strongly disagree

4. Boys work harder to write the details in a science report than girls do.

strongly agree	agree	don't know	disagree	strongly disagree

5. Girls are better at cleaning up and storing equipment than boys are.

strongly agree	agree	don't know	disagree	strongly disagree

6. Girls get more awards at science fairs than boys do because they spend more time doing their projects.

strongly agree	agree	don't know	disagree	strongly disagree

7. Boys make better grades in science than girls do.

strongly agree	agree	don't know	disagree	strongly disagree

8. Girls give more information than boys do in science class discussions.

strongly agree	agree	don't know	disagree	strongly disagree

9. A chemistry set is a good birthday present for girls.

strongly agree	agree	don't know	disagree	strongly disagree

10. Boys get to do more than girls get to do in science class.

strongly agree	agree	don't know	disagree	strongly disagree

11. Boys break more of the laboratory equipment than girls do.

strongly agree	agree	don't know	disagree	strongly disagree

12. A boy instead of a girl should be left in charge of the group if the teacher had to leave.

strongly agree	agree	don't know	disagree	strongly disagree

13. A girl who makes the highest grade on a science test should not study as hard next time so she will be liked more by the boys.

strongly agree	agree	don't know	disagree	strongly disagree

14. Girls set higher career goals for themselves than boys do.

strongly agree	agree	don't know	disagree	strongly disagree

15. Boys like science fiction movies more than girls do.

strongly agree	agree	don't know	disagree	strongly disagree

16. Girls need more help than boys need when doing science experiments.

strongly agree	agree	don't know	disagree	strongly disagree

17. Girls ask questions which the science teacher cannot answer more often than boys do.

strongly agree	agree	don't know	disagree	strongly disagree

18. Teachers encourage boys to study science more than they encourage girls.

strongly agree	agree	don't know	disagree	strongly disagree

19. Boys usually have better ideas than girls have for setting up science equipment.

strongly agree	agree	don't know	disagree	strongly disagree

20. Teachers ask girls to help more often than they ask boys when an experiment is done in front of the group.

strongly agree	agree	don't know	disagree	strongly disagree

21. Girls are better sports than boys are when an experiment is ruined by accident.

strongly agree	agree	don't know	disagree	strongly disagree

22. Girls usually score higher on tests in mathematics than boys do.

strongly agree	agree	don't know	disagree	strongly disagree

23. Girls usually take the lead in doing science experiments.

strongly agree	agree	don't know	disagree	strongly disagree

24. Boys are usually more careful than girls are not to hurt the feelings of others in class.

strongly agree	agree	don't know	disagree	strongly disagree

25. Girls are more careful than boys are not to hurt the feelings of others in class discussions.

strongly agree	agree	don't know	disagree	strongly disagree

26. Boys like girls more who are quiet and do not compete with them in class.

strongly agree	agree	don't know	disagree	strongly disagree

27. Girls can make important decisions more quickly than boys can.

strongly agree	agree	don't know	disagree	strongly disagree

28. Boys give more interesting oral reports in science than girls do.

strongly agree	agree	don't know	disagree	strongly disagree

29. Boys are willing to take more risks than girls are to try out a new idea in science.

strongly agree	agree	don't know	disagree	strongly disagree

30. Boys usually understand the personal problems of classmates better than girls do.

strongly agree	agree	don't know	disagree	strongly disagree

31. Boys usually are better achievers in mathematics than girls are.

strongly agree	agree	don't know	disagree	strongly disagree

32. Girls will usually give a better answer than boys will to hard science questions.

strongly agree	agree	don't know	disagree	strongly disagree

33. Boys set higher career goals for themselves than girls do.

strongly agree	agree	don't know	disagree	strongly disagree

34. Boys are more careful than girls are in following the exact directions for doing a science experiment.

strongly agree	agree	don't know	disagree	strongly disagree

35. Science teachers ask girls easier questions than they ask boys.

strongly agree	agree	don't know	disagree	strongly disagree

36. Girls keep working longer than boys do to solve a hard math problem.

strongly agree	agree	don't know	disagree	strongly disagree

37. Girls keep better notebooks in science than boys do.

strongly agree	agree	don't know	disagree	strongly disagree

38. Teachers help boys with their assignments more than they help girls.

strongly agree	agree	don't know	disagree	strongly disagree

39. Boys take better notes in class than girls do.

strongly agree	agree	don't know	disagree	strongly disagree

40. Boys spend more time studying for their science tests than girls do.

strongly agree	agree	don't know	disagree	strongly disagree

41. Boys ask more questions in science class than girls ask.

strongly agree	agree	don't know	disagree	strongly disagree

42. Girls who like science are usually tomboys.

strongly agree	agree	don't know	disagree	strongly disagree

43. Boys would volunteer more quickly than girls would to have their finger pricked to get blood for a science experiment.

strongly agree	agree	don't know	disagree	strongly disagree

44. Boys who like science are bookworms.

strongly agree	agree	don't know	disagree	strongly disagree

45. Girls don't like to dissect animals.

strongly agree	agree	don't know	disagree	strongly disagree

46. A girl will figure out a new and better way to do an experiment more often than a boy will.

strongly agree	agree	don't know	disagree	strongly disagree

47. Once girls decide to do a science project, they do it step-by-step.

strongly agree	agree	don't know	disagree	strongly disagree

48. Girls make up their minds on controversial issues faster than boys do.

strongly agree	agree	don't know	disagree	strongly disagree

49. Boys spend more time on science assignments than girls spend.

strongly agree	agree	don't know	disagree	strongly disagree

ID _____

Career Appropriateness Scale

Listed below are some science career areas which boys and girls might study. Read the name of each job. Decide whether a girl should or should not consider this as a possible career choice. Decide whether a boy should or should not choose this as a possible career. You will need to make two (2) X marks for each area.

Example:	GIRLS		BOYS	
salesclerk	should	should not	should	should not
	X		X	

	GIRLS		BOYS	
	should	should not	should	should not
1. Electrician				
2. Dietitian				
3. Physicist				
4. Chemist				
5. Librarian (Science)				
6. Biologist				
7. Laboratory Technician				
8. Nurse				
9. Engineer				
10. Physical Therapist				
11. Electronics Technician				
12. Computer Operator				
13. Forester				
14. Architect				
15. Veterinarian				
16. Medical Secretary				
17. Dentist				
18. Astronaut				

	GIRLS		BOYS	
	should	should not	should	should not
19. Science Teacher	_____	_____	_____	_____
20. Mathematician	_____	_____	_____	_____
21. Medical Doctor	_____	_____	_____	_____
22. Paramedic	_____	_____	_____	_____

ID _____

Who Would You Ask for Advice?

Many people help you and other students decide what courses to take in high school. We want to know whose advice you consider important when choosing classes, especially any science classes. Pretend that you are planning your school schedule for the next few years and that you are thinking about taking an advanced science course such as chemisty or physics. Who would be the person who would help you make this decision?

Below are 36 pairs of people who might help you decide whether to take the advanced science class. Please circle the person in each pair whose advice you would respect more in making this decision.

Example: A. (Mother) Sister

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1. Father - Mother
2. Father - School Counselor
3. Father - Teacher
4. Father - Boy friend
5. Father - Girl friend
6. Father - Brother
7. Father - Sister
8. Father - Adult friend/relative
9. Mother - School Counselor
10. Mother - Teacher
11. Mother - Boy friend
12. Mother - Girl friend
13. Mother - Brother
14. Mother - Sister
15. Mother - Adult friend/relative
16. School Counselor - Teacher
17. School Counselor - Boy friend
18. School Counselor - Girl friend
19. School Counselor - Brother
20. School Counselor - Sister

21. School Counselor - Adult friend/relative

22. Teacher - Boy friend

23. Teacher - Girl friend

24. Teacher - Brother

25. Teacher - Sister

26. Teacher - Adult friend/relative

27. Boy friend - Girl friend

28. Boy friend - Brother

29. Boy friend - Sister

30. Boy friend - Adult friend/relative

31. Girl friend - Brother

32. Girl friend - Sister

33. Girl friend - Adult friend/relative

34. Brother - Sister

35. Brother - Adult friend/relative

36. Sister - Adult friend/relative

ID _____

Male _____ Female _____

Age _____

PICP-Q

Directions: Read each one of the following statements carefully. Then answer the best that you can. Circle the number that best describes how you feel.

5 = very encouraging
4 = encouraging
3 = no opinion
2 = discouraging
1 = very discouraging

1. If you had the ability, how would your **father** feel about your doing the following:

Becoming a medical doctor	5	4	3	2	1
Becoming an artist	5	4	3	2	1
Becoming a science librarian	5	4	3	2	1
Becoming a computer operator	5	4	3	2	1
Becoming a science teacher	5	4	3	2	1
Becoming an engineer	5	4	3	2	1
Becoming a mayor or senator	5	4	3	2	1

2. If you had the ability, how would your **mother** feel about your doing the following:

Becoming a medical doctor	5	4	3	2	1
Becoming an artist	5	4	3	2	1
Becoming a science librarian	5	4	3	2	1
Becoming a computer operator	5	4	3	2	1
Becoming a science teacher	5	4	3	2	1
Becoming an engineer	5	4	3	2	1
Becoming a mayor or senator	5	4	3	2	1

5 = very encouraging
4 = encouraging
3 = no opinion
2 = discouraging
1 = very discouraging

3. If you had the ability, how would your **father** feel about your taking the following subjects?

chemistry	5	4	3	2	1
science - 8th & 9th grades	5	4	3	2	1
physics	5	4	3	2	1
biology	5	4	3	2	1
Algebra I	5	4	3	2	1
advanced algebra	5	4	3	2	1
trigonometry	5	4	3	2	1
geometry	5	4	3	2	1
advanced math	5	4	3	2	1

4. If you had the ability, how would your **mother** feel about your taking the following subjects?

chemistry	5	4	3	2	1
science - 8th & 9th grades	5	4	3	2	1
physics	5	4	3	2	1
biology	5	4	3	2	1
Algebra I	5	4	3	2	1
advanced algebra	5	4	3	2	1
trigonometry	5	4	3	2	1
geometry	5	4	3	2	1
advanced math	5	4	3	2	1

5 = very encouraging
4 = encouraging
3 = no opinion
2 = discouraging
1 = very discouraging

5. How much does your **father** encourage you to:

ride motorcycles	5	4	3	2	1
do dishes	5	4	3	2	1
use tools to fix things	5	4	3	2	1
use hammer	5	4	3	2	1
do yard work	5	4	3	2	1
play sports	5	4	3	2	1
try to fix the car	5	4	3	2	1
sew new clothes	5	4	3	2	1
cook dinner	5	4	3	2	1
be a cheerleader	5	4	3	2	1
go to dances	5	4	3	2	1
listen to radio	5	4	3	2	1
use a screwdriver	5	4	3	2	1
play football	5	4	3	2	1
talk about boy/girl friends	5	4	3	2	1
twirl a baton	5	4	3	2	1
clean room	5	4	3	2	1
keep straight posture	5	4	3	2	1
look attractive	5	4	3	2	1
fight for yourself	5	4	3	2	1
read books	5	4	3	2	1
do needlepoint	5	4	3	2	1
use handtools	5	4	3	2	1
raise vegetables	5	4	3	2	1
raise flowers	5	4	3	2	1
do artwork such as finger painting	5	4	3	2	1

5 = very encouraging
4 = encouraging
3 = no opinion
2 = discouraging
1 = very discouraging

6. How much does your **mother** encourage you to:

ride motorcycles	5	4	3	2	1
do dishes	5	4	3	2	1
use tools to fix things	5	4	3	2	1
use hammer	5	4	3	2	1
do yard work	5	4	3	2	1
play sports	5	4	3	2	1
try to fix the car	5	4	3	2	1
sew new clothes	5	4	3	2	1
cook dinner	5	4	3	2	1
be a cheerleader	5	4	3	2	1
go to dances	5	4	3	2	1
listen to radio	5	4	3	2	1
use a screwdriver	5	4	3	2	1
play football	5	4	3	2	1
talk about boy/girl friends	5	4	3	2	1
twirl a baton	5	4	3	2	1
clean room	5	4	3	2	1
keep straight posture	5	4	3	2	1
look attractive	5	4	3	2	1
fight for yourself	5	4	3	2	1
read books	5	4	3	2	1
do needlepoint	5	4	3	2	1
use handtools	5	4	3	2	1
raise vegetables	5	4	3	2	1
raise flowers	5	4	3	2	1
do artwork such as finger painting	5	4	3	2	1

Check (✓) one in each question.

7. As you see it now, how many more math courses do you plan to take in high school?

_____ 4 or 5 _____ 2 or 3 _____ 1 _____ no more

8. As you see it now, how many more science courses do you plan to take in high school?

_____ 4 or 5 _____ 2 or 3 _____ 1 _____ no more

9. Do you plan to graduate from high school?

_____ yes _____ no _____ maybe

10. Are you going to college?

_____ yes _____ no _____ maybe

11. How interested are you in science courses?

_____	_____	_____	_____	_____
very interested	interested	don't know	uninterested	very uninterested

12. How interested are you in math courses?

_____	_____	_____	_____	_____
very interested	interested	don't know	uninterested	very uninterested

13. Would you be interested in having a career that required knowing math and science?

_____ yes _____ no _____ maybe

14. Does your father expect you to work at a career when you get older?

_____ yes _____ no _____ maybe

15. Does your mother expect you to work at a career when you get older?

_____ yes _____ no _____ maybe

16. Would your father encourage you to become a scientist?

_____ yes _____ no _____ maybe

17. Would your mother encourage you to become a scientist?

_____ yes _____ no _____ maybe

ID NUMBER _____

SEX: Male _____ Female _____

ANSWER EACH QUESTION BELOW. PLEASE WRITE THE **FIRST** AND **LAST** NAME OF THE BOY OR GIRL. PLEASE DO NOT LEAVE ANY BLANK.

1. What girl in this class would you like to have as a best friend?

2. What boy in this class would you like to have as a best friend?

3. Which girl in this class is your best friend?

4. Which boy in this class is your best friend?

5. If you had to pick someone in this class to work with on a science project or experiment, who would it be?